INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & MANAGEMENT

DESIGN OF WIND TURBINE BLADE BY COMPOSITE MATERIAL

AJAY SHARMA[1]*, AMIT SONI[2]
[1]Central India Institute of Technology, Indore
[2]RKDF School of Engineering, Indore

ABSTRACT

Wind turbine blades are one of the key components of a complete wind turbine system due to their significant effect in the overall performance of the system. They are fabricated with composite materials with polymeric matrices and the current manufacturing processes are still highly manual, which results in different types of manufacturing defects. Thus, non-destructive testing (NDT) techniques that provide surface and internal information of the blade are necessary to absorbe those defects. The study on detection capabilities, performance of ultrasonic and X-ray CT techniques for the inspection of E-glass/epoxy and E-glass/vinylester specimens are reported.

Keywords: UT-Ultrasonic test, NDT-Non destructive testing

1. INTRODUCTION

The composite materials with polymeric matrices are the current material of choice for wind turbine blades. Referable to the high tensile modulus and lower density, carbon fibers are sometimes employed for some specific structural areas of the vanes. But owing to the lower price and acceptable structural properties, the glass fibers are the most extensively used, being the E-glass the most usual case of glass fiber Relating to the resin, polyester resins have been historically the resins of choice as a natural whole tone from the aeronautic industry taking advantage of the accumulated manufacturing know-how. However, the family of epoxy resins offers high mechanical and adhering properties and experiences become even more coarse than the polyester resins in the wind turbine blade manufacturing industry in the final age.

2. NON DESTRUCTIVE TESTING

The wind turbine blades are manufactured with low pressure resin injection techniques like RTM (resin transfer molding) or by preparing technology in open or close molds, where the fibers are usually laid manually. The high manual component of current manufacturing processes results in different cases of defects; delaminations, voids, inclusions, cracks, dry fibers, defective fiber alignment, and so on. Different non-destructive techniques (NDT) capable of evaluating internal defects have been offered for wind turbine blade inspection. Some of the most relevant NDT techniques may be the following; choreography techniques, thermography techniques, ultrasonic techniques and X-ray CT techniques.

3. EXPERIMENTAL SETUP AND PROCEDURE

3.1 Specimen Preparation

Two different specimens E-glass fiber/epoxy and E-glass fiber/vinylester are Made and in order to take into account the high thickness of wind turbine blades, thick specimens with overall dimensions of 300 x 160 x 10 mm have been Manufactured. This is a significant thickness compared to typical part thicknesses of other industries like aeronautics that will enable the analysis and detection of thickness related inspection drawbacks. Concerning the damage, simulated delaminations have been generated. As each inspection technique under evaluation is established on a different physical phenomenon, the most adequate way to generate simulated delaminations depends on each inspection technique. However, in parliamentary procedure to be capable to compare all four inspection techniques, a unique standard approach has been taken. This way, Teflon inserts of different dimensions were presented at different depths during the hand lay up process, and the same specimens were used in all the inspection techniques. The current inspection objective in the wind turbine blade fabrication. Is to detect unacceptable defects, merely not to measure initiating defects that will potentially contribute to future unacceptable defects.

4. RESULTS AND DISCUSSION

4.1 Ultrasonic Test Result

For the ultrasonic inspection, a broadband phased array probe 5L64 of 64 elements and a conventional transducer of 15 mm of diameter have been used with center frequencies of 5 MHz and 10 MHz respectively. For the proper ultrasonic wave transmission a gel has been employed as a coupling agent. The measurements have been executed at normal

incidence in pulse-echo mode. By using initial echo and Back wall echo the specimen thickness is placed and the intermediate echo points are studied in the defect identification two different specimens are examined for the ultrasound and the test results are recorded in the fig. 1&2. The intermediate echo points are taken as the defect portion. The measurements have been executed at normal incidence in pulse-echo mode. Every bit a first approach, initial measurements with both transducers have been performed and compared. A higher frequency wave is desirable to make the smaller divergence angle and higher sensitivity and in-depth resolution. On the other hand, due to the intrinsic density-inhomogeneities of composite materials, the scattering that undergoes the acoustic wave is relatively high.

Fig.1 ultrasonic test result for E-glass fiber/epoxy resin specimen

Fig.2 ultrasonic test result for E-glass fiber/vinylester specimen

4.2 X-Ray, CT Test Result

The X-ray CT inspections have been done by a Metrotom 1500 CT machine. The used X-ray tube voltage and volume is 220 KV and 400µA respectively, and a copper, filter of 0.75 mm has been utilized. An integration time of 2 seconds has been used and the voxel size after the reconstruction has been of Vx = 168 µm. By using the X-ray in the specimens the defects in the specimens are identified. The X-ray results are shown in the fig. 3&4

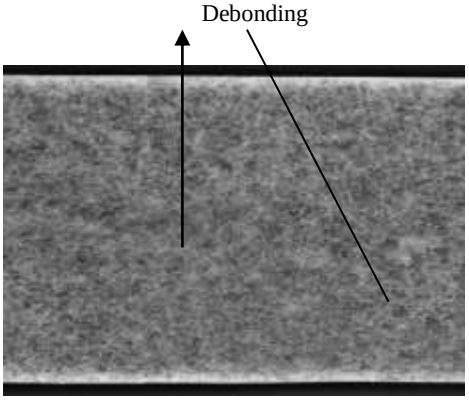

Fig.3 X-ray CT technique result E-glass/epoxy resin specimen

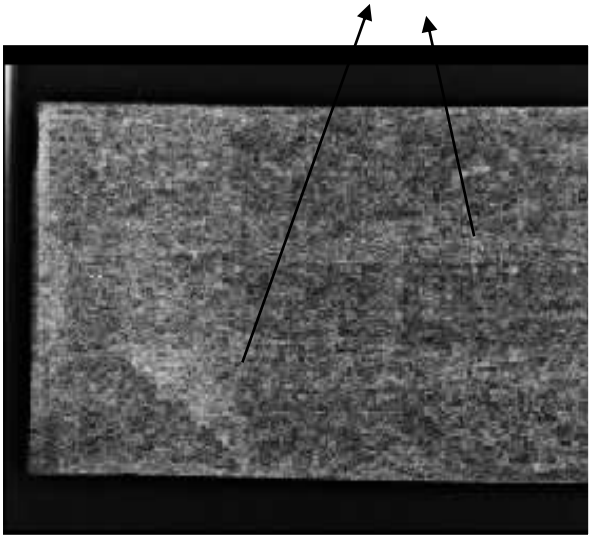

Fig.4 X-ray CT technique result glass/vinylesterer resin specimen

CONCLUSION

In this study, the performance of two NDT inspection techniques for the inspection of damage in the materials used for wind turbine blade material have been analyzed .

- In the X-ray CT technique depending is noted in E-glass/epoxy resin and delamination is noted in E-glass/vinylester resin.
- The ultrasonic test report shows that E-glass fiber/epoxy resin is better than that of the E-glass fiber/vinylester resin by comparing the defects

REFERENCES

[1] Marin.J.C, Barroso.A, Paris.F, Canas.J, (2009) "Study Of Fatigue Damage In Wind Turbine Blades", *Journal Of Engineering Failure Analysis*, Vol.16, pp.656-668

[2] Lambert.J, Chambers.A, Sinclair, Spearing.S.M, (2012) "3D Damage Characterisation And The Role Of Voids In The Fatigue Of Wind Turbine Blade Material", *Journal Of Composite Science And Technology*, Vol.72, pp.337-343

[3] Henrik Stensgaard Toft, Kim Branner, Peter Berring, John Dalsgaard Sørensen, (2011) "Defect Distribution And Reliability Assessment Of Wind Turbine Blades", *Journal Of Engineering Structures*, Vol.33, pp.171-180

[4] Fangfang Song, Yihua Ni, Zhiqiang Tan, (2011) "Optimization Design, Modeling And Dynamic Analysis For Composite Wind Turbine Blade", *Journal Of Procedia Engineering*, Vol.16, pp.369-375

[5] Sabhah Ataya, Mohamed M.Z, Ahmed, (2013) "Damages Of Wind Turbine Blade Trailing Edge: Forms, Location, And Root Causes", *Journal Of Engineering Failure Analysis*, Vol.67, pp.234-259

[6] Bulent eker, Aysugul Akdogan, (2006) "Using Of Composite Material In Wind Turbine Blades", *Journal Of Applied Science*, Vol.14, pp.2917-2921

[7] Pongtorn prombut, (2010) "Manufacturing Of Prototype Blade For Small Wind Turbine Blade", *Journal Of Procedia Engineering*, Vol.44, pp.452-459

[8] Alan, (2009) "Non-Destructive Evaluation Of Wind Turbine Blade Using An Infrared Camera", *Journal Of Non Destructive Testing*, Vol.52, pp.52-63

[9] Anne Jungert, (2008) "Damage Detection In Wind Turbine Blades Using Two Different Acoustic Techniques", *Journal Of Non Destructive Testing*, Vol.16, pp.326-330