4.2.1. INSPECTION OF COMPLICATED COMPOSITE STRUCTURES USING THE ADAPTED ULTRASONIC TECHNIQUES

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The objective of this study was to adapt different ultrasonic techniques for the inspection of complicated composites objects and to compare the obtained results. Composite materials itself are difficult object for investigations. Furthermore, the complicated objects made from composite materials demand even more advanced inspection techniques.

The study was carried out on a wind turbine blade sample constructed from a composite glass fibre reinforced plastic (GFRP) material. Wind turbines have been in use for many years and are becoming increasingly popular. In order to maximise the efficiency of the energy exploited from the wind, the various components of a wind turbine need to be inspected regularly. One of the most critical components of a wind turbines are the blades. The multi-layered structure of the wind turbine blade consists of a skin layer (dye coating with GFRP), glue / foam layer and a GFRP foundation layer. The sample possessed a number of artificial defects and a number of manufacturing non-homogeneities, like delaminations between adjacent layers of GFRP, lack of glue, etc. The artificial defects on the main spar and on the trailing edge of the sample were investigated.

Several different ultrasonic techniques were adapted and used for the non-destructive testing of the wind turbine blade sample due to the multi-layered, variable thickness and arbitrary curved surface and a large variety of defects. The purpose of the study was to evaluate the imaging capabilities of these different techniques through attempts to identify and characterise the various defects.

Two different NDT techniques were investigated: air-coupled ultrasonic technique and pulse-echo ultrasonic technique in which for acoustic coupling a moving water container is used.

The used air-coupled ultrasonic measurement system was developed at the Ultrasound Institute of Kaunas University of Technology, Lithuania. A pair of air-coupled transducers was used for non-contact scanning of the wind turbine sample. The specially developed pair of air-coupled ultrasonic transducers (transmitter and receiver) had a central frequency of 290 kHz.

The novel pulse-echo immersion ultrasonic measurement system with a moving water container was developed at the Ultrasound Institute in Kaunas University of Technology, Lithuania. The novel combination of the contact pulse-echo and the immersion ultrasonic technique was performed using planar 400 kHz transducer.

The measurements performed show that the adapted air-coupled ultrasonic technique using Lamb waves, proved to be the most promising in terms of implementation as it requires only one side access. However, the novel combination of contact pulse echo and immersion techniques using a moving container of water identified the shape and size of defects better. Through comparisons of images obtained using different ultrasonic techniques, different defect properties can be identified. Hence, the best results are achieved when different techniques are combined together.