Non Destructive Evaluation for Composites

Workshop summary – 15th June 2010, NetComposites

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Background
Fibre reinforced polymer composite materials are increasingly used in industry; both monolithic and more complex sandwich structures. Their application has spread from high technology industries such as aerospace and defence to other sectors including chemical, offshore, marine, transport and civil applications. Each industry faces different challenges and the materials used and nature of the composite fabrications may differ.

A common feature is that defects and damage can occur, which reduce the strength and stiffness, and determine the safe working life of composite structures. These are complex, various and intricately related to a variety of service conditions and failure modes under many different circumstances. Defects may be introduced during manufacture, accidentally in-service or perhaps unavoidably in design because of the requirement to introduce discontinuities such as cut-outs, ply drops or structural connections.

NDE techniques
There are a number of common and established methods for non-destructive evaluation (NDE) are routinely available and there have been significant advances in NDE systems and technology. Newer methods such as laser shearography and transient thermography are now well accepted in aerospace and marine sectors and finding applications elsewhere; in many cases replacing traditional methods such as ultrasonic C-scanning. In ultrasonic systems the development of modern digital flaw detectors and improvements like wheel probes have opened up new avenues of data acquisition and analysis. Several newer and specialised methods such as microwaves, acoustography and vibro-thermography which are also showing promise in specific applications.

The choice of NDE method will depend on a number of factors including access, defect type, thickness, surface condition and material quality. In-service inspection is more difficult than in manufacture.

Challenges
Whilst NDE techniques are well established there are some key challenges still facing the industry:

- Thickness of composites – particularly in aerospace applications
- Accessibility for inspection
- Coupling and surface condition – can be quite rough
- Positive materials identification
- Signal attenuation and scattering
- Inhomogeneous and anisotropic structure
- Lack of adequate standards – but the situation is improving
- Interpretation of results – analysing the data obtained, what does it mean/represent?
- Unfamiliarity of inspectors with non-metallic structures

- Increased reliance on operator experience
- Inspection of repairs on composite structures

Current research
Research is being carried out at the University of Bristol to inspect at an early stage in the manufacturing process in order to reduce wastage due to failed panels at the end of manufacture. They have looked at 3 different methods: Laser Projection Technologies (LPT), Automatic Ply Verification (APV) and Fibre inspection with mulit-directional illumination (Filainspect). These techniques all have benefits and limitations so the team have investigated non-contact metrology using a hand-held triangulation scanner. This technique detects defects such as wrinkles and bridging – if treated at the point of detection, this can reduce manufacture costs associated with lay-up quality related issues in components, especially those of fixed LT/TE panels or secondary structures. The non-contact scanner is in collaboration with Central Scanning Ltd and the equipment is made by Steinbichler Optotechnik GmbH.

Research at TWI is investigating how to measure/inspect structures from a distance.

Sources of information
There are several sources of additional information to assist industry users:

Interactive knowledge base (IKB) on NDE of composites:
www.netcomposites.com/composite-tools.asp

HOIS Good Practice Guide: www.hois2000.com

Materials Solutions: www.materialssolutions.info

Standards for composite NDE:
- ISO 14692 Pt 4
- Norsok M-622 (2005)
- DNV Standard OS-C501

HSL/HSE Inspection Guidance documents

British Institute of NDT (BINDT): www.ndt.net

NCN Best Practice Guide on NDE Techniques for Composites: www.ncn-uk.co.uk

Future development needs
The presentations from the workshop highlighted some key areas for future work:
- Improvements in rapid screening methods and monitoring techniques
- Improved standards for in-service composite NDE
- Improved defect assessment methods
- Reliability and performance of composite NDE methods probability of detection (POD)
- Use of simulation and NDE reliability models