Line Maintenance Solutions for Composite Damage Evaluation

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Abstract:

New approaches to NDE will be necessary when civil aircraft with significant composite structures begin widespread commercial operations. This paper will review newly developed ultrasonic instrumentation, imaging and analysis solutions to support ramp operations, perform standard maintenance and repair-inspection of composite aircraft structures. Data management capabilities that increase the information collected and management of this information will also be presented

Keywords: Composite, Field maintenance, Barely visible Impact Damage, Inspection data management

1. Introduction

Although carbon fiber reinforced plastic (CFRP) composite has been used for structural components in military aircraft for over 20 years, commercial transport air vehicles with over 45% composite content are just beginning to enter the market. Aircraft OEM's have thoroughly evaluated these materials, using them as part of an aircraft system which will reduce both weight and maintenance requirements.

Fuselage parts made from CRRP composite are lighter and stronger than typical aircraft aluminium. In addition to these differences, composite unlike metal, CFRP does not visibly show impact artifacts (dents) and may not show cracks or fatigue damage at the outer suface. Minor ramp interactions may cause 'barely visible impact damage" which although not serious may look visibly different than a more serious delamination or damage condition.

The entry of composite based aircraft into the commercial transport fleet will create an opportunity for new inspection devices and procedures in addition to the well-established techniques for traditional materials. This paper will review equipment and capabilities for evaluating composite parts, and present an option for integrated inspection data management of such data.

2. Evaluation & Inspection

2.1 Line maintenance devices

A major aircraft OEM anticipates the need for a simple device for the assessment of possible damage to composite fuselage when conditions do not require advanced NDT.

The use of such a device intended to provide rudimentary test capability must be called out in the OEM's structural repair manual. When such a situation exists, line maintenance personnel without specialized training can gather required data about the suspect area to dispatch planes if the data meets OEM provided limits.

GE Inspection Technologies will be producing the BondTracer ™, an ultrasonic instrument and probe kit with a simple user interface that allows trained flight line mechanics to confidently trace, map, size and compare the severity of damage caused by a minor impact to OEM established limits for certain (specific) airframes. They may then decide if further assistance from NDI/NDT inspectors is required or if the aircraft can remain serviceable and continue to fly.

In the hands of trained flight line mechanics, this instrument kit will help prevent the unnecessary grounding of aircraft due to non-availability of NDI/NDT services at an airport, when for example: a baggage vehicle bumps the airplane and scratches or scrapes off some paint. Trained flight line mechanics can detect and measure the underlying damage, compare it to a maintenance manual or an acceptability table and decide if more NDT is needed or allow the aircraft to remain airworthy and continue to fly.

The instrument will essentially be " trained " on a good piece of composite and use algorithms in it's software to compare a suspected piece of like thickness against the parameters that were stored from the good piece. Portions of the plane that are comparable will produce a green light on the instrument, while portions of lesser thickness than what the instrument was trained on will produce a red light. The unit will operate from three " AA" Alkaline batteries.

2.2. UT Phased Array evaluation

Skilled inspection by certified NDT technicians will continue to be a routine part of the operating & maintenance procedures for composite aircraft. For composite inspection of many types, phased array ultrasound will be a valuable tool for detecting and imaging defects throughout the composite structure.

Phased array solutions rely on the excitation of individual elements in a multi-element probe, in terms of the element's amplitude and the delay between the energising of consecutive elements. In this way, the wavefronts created can be time-delayed and synchronized for phase and amplitude such that a focused, steerable beam is produced. As a result, a single phased array probe can perform inspection tasks normally requiring large numbers of conventional probes or multiple scanning passes. This means that inspections are faster, inspection equipment is more flexible as set-up change over can be achieved very quickly and there is no need to carry different sets of probes for different inspection tasks. In addition, the real time, sector scan imaging of phased array provides an integrated, cross-sectional, easy-to-understand visualisation of any area or component under inspection

Although many phased array ultrasound instruments are available, GEIT's Phasor XS is a simple, portable device designed to simplify manual testing such as described

here. The instrument offers 64 phased array channels as well as a conventional channel so that it can also be used for conventional ultrasonic inspection, including corrosion and thickness measurement. It is packaged within a successful, proven operating platform, so that operators who have been using GE's flaw detectors will comfortably adapt to familiar features such as thumb wheel controls. Operators will also appreciate the easy-to-understand, menu-driven inspection instructions, plus calibration and set-up wizards, which ensure a short learning curve in the introduction to phased array techniques.

2.3 Other techniques

In addition to simple line maintenance devices for sizing the defects, and more sophisticated UT Phased Array for Non-Destructive Inspection and evaluation, other traditional and less-common techniques are likely to be employed in the maintenance of these aircraft. Despite the unprecedented amounts of CRFP used, traditional NDT will be necessary for the 50% of the aircraft which is not composite, requiring eddy current, eddy current array, digital and film radiography as well as other traditional techniques.

Infra-red technology is a technique which is uniquely suited to composite materials due to the low thermal conductivity of CFRP, as compared to metals. In thermography, a part or test article is uniformly heated by an external source, after which the surface temperature is monitored and recorded. Subsurface anomalies will disrupt the heat flow through apart and be detected by the device monitoring the surface temperature – usually an infrared camera.

3.0 Data Management solutions

New aircraft platforms such as Boeing 787 or Airbus A350XWB offer an opportunity to take advantage of new inspection techniques and equipment as well as new software & data management tools.

In the NDT field, developments in digital radiography, automated ultrasonic, eddy current instrumentation and remote visual inspection systems are now possible due to significant advances in digital technology. Although the industry expects this in the advancement of equipment technology, it is often overlooked in the domain of inspection data management.

In every NDT technique or modality, more and more information is generated, and more sophisticated algorithms are used to analyze or display this data. Although the collection and management of this data can be a challenge, evolving software tools and usage management systems can and will likely be developed to input this data into an integrated system to acquire the information, share it, analyse it and then manage it in an intelligent, fast and accessible manner.

Using a standard data protocol like DICONDE (Digital Imaging Communication of Non-Destructive Evaluation) leveraged from the medical industry, provides a seamless way for images and data to be collected and shared. A DICONDE software

data management platform allows more efficient data searching for inspection data from all modalities; it can control image information workflow so that data can be routed to other experts for further analysis. Quick access to previous inspection data can boost up productivity output by as much as 50%.

Pre-inspection plans can now be formulated more efficiently by taking actual inspection history into account. Operators can quickly and easily gather information from inspections over the life of a critical part, easily able to share this data electronically with expert inspectors or engineers at various locations.

Rhythm™ is a software platform from GE Inspection Technologies based on the DICONDE standard. This inspection data solution is divided into four separate modules, each focused on driving inspection and data management productivity to users. Currently Rhythm is available for digital & computed radiography, visual inspection, as well as initial ultrasound capability. Eddy current and upgrades to Ultrasound capability are planned for early 2009.