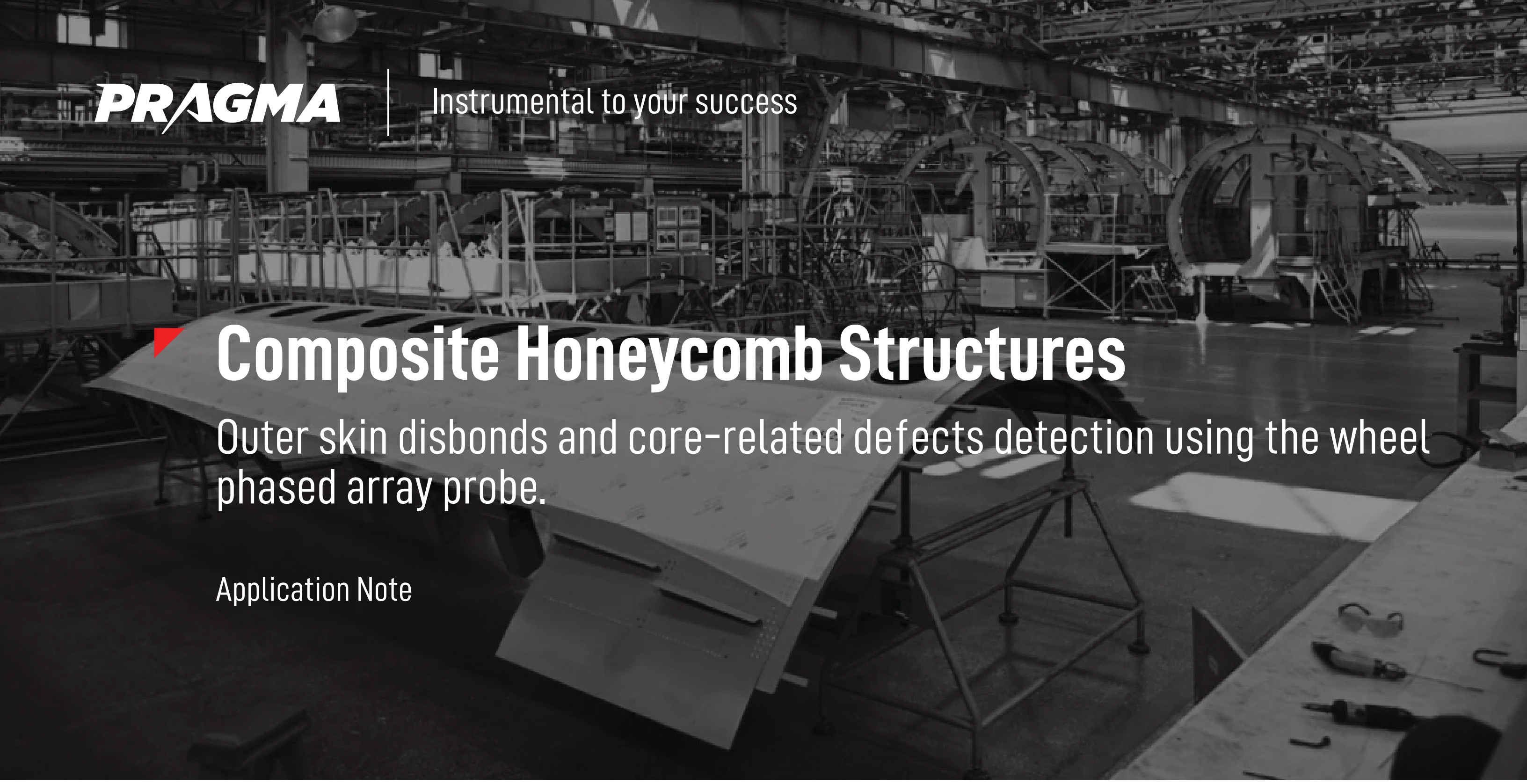

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Composite Honeycomb Structures

Outer skin disbonds and core-related defects detection using the wheel phased array probe.

Application Note

Composite honeycomb structures are highly suitable for applications as structural components that require low-mass and flexibility. It is therefore using in fields such as aerospace, marine, and civil engineering. The composite sandwich structure consists of two thin but stiff composite skins separated by a light-weight core.

Because aircraft structures are subjected to impacts and lightning strikes, reliable and efficient Nondestructive Testing (NDT) methods are needed to quickly assess possible damage.

The use of advanced composites has been rapidly increasing in a wide range of industrial applications due to its excellent proprieties such as its strength-to-weight ratio. Currently, composite components represent 50% of the weight of commercial air frames with sandwich panels most often used for nacelles, rudders, elevators and wing-lets.

Aerospace honeycomb panels typically consist of two outer layers (or skins) over a lightweight core, a combination proven to offer an excellent strength-to-weight ratio; although foam cores are used, aluminium honeycomb cores are preferred. The top and bottom skins are typically bonded to the core using an adhesive film.

The strength of the sandwich structure is a result of the combination of the properties of the face skins, core, and interface. Any damage accumulated in one or more of these base materials will have an degradation effect on the properties of the sandwich structure that needs to be detected and categorized.

It's absolutely crucial to have a reliable, portable and effective inspection solution for in-service testing of these composite structures.

Types of defects

The defects of sandwich structures resulting from fabrication, assembly or during service phase can be commonly found in the forms of skin core disbonding, crushed core and delaminations or cracks at the skin.

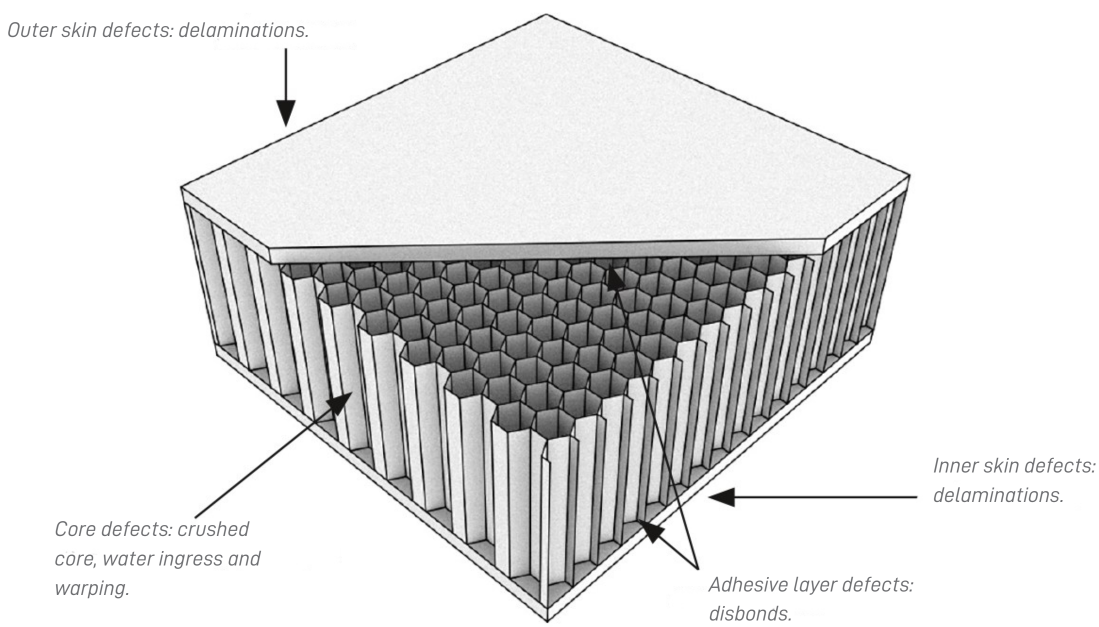
In-service damage is most often caused by impacts. In monolithic composites this results in matrix cracking and delaminations of the ply layers. In some cases the damage is visible from the surface but internal delamination damage can go undetected.

Honeycomb structures can suffer from the same matrix cracking and delaminations in the skins when impacted, but other types of failure can also occur. For example, disbonding can be caused at the skin-to-adhesive interface.

Core crushing occurs where the impact energy is absorbed by the core, which distorts and folds and greatly reduces it's compressive strength.

When introduced in honeycomb structure, moisture can degrade epoxy adhesives that bond the carbon sheet to the honeycomb core resulting in disbonding. Moisture can penetrate inside the sandwich composite structures in many ways, e.g. through edge seals, micro cracks on the surfaces or by diffusion through the skin.

The focus of this document are in-service defects and the inspection challenges associated with these types of flaws.



Our Solution

Phased array Ultrasonic Testing (PAUT) technology is based on the capacity to electronically modify ultrasonic beams generated by a phased array probe that contains multiple small elements.

When these elements are excited with different time delays (focal laws), the beams can be steered at different angles, focused at different depths or multiplexed over the length of a long array, creating an electronic movement of the beam. A small group of elements, defined as the active aperture, is activated to generate an ultrasonic beam propagating normal to the surface.

This group of elements is then indexed using electronic multiplexing, creating a true physical movement of the ultrasonic beam under the array with an index as small as 1 millimeter.

Ultrasonic phased array inspection of a wind blade can be performed in different ways. It can be operated manually with or without an encoder, and it can also be operated in a semi or fully automated manner.

Instruments

The PragmaPro comes with conventional UT, Time-Of-Flight-Diffraction (TOFD) and all beam-forming phased array UT techniques for single-beam and multi-group inspection.

- Battery operated portable instrument.
- 32 channels. Multiplexing up to 128 elements.
- Best in class waveform signal.
- Variety of 6 Degree of freedom encoding solutions.

Wheel Probe

The probe consists of a phased array probe that is 51.2 mm (2 in.) long with 64 elements immersed in a water tire and requires minimum pressure to couple to the part.

- 10 MHz is prefered for optimum resolution of the honeycomb structure.
- Tire's material has an acoustic impedance that is closely matched to water.
- Built-in encoder for simple line scans. Ability to index multiple line scans to form a C-Scan map.
- Optional laser guides can be added for guidance.

MagTracker

The MagTracker uses an electromagnetic transmitter to create an envelope of up to 1 m^3 of tracking volume. Sensors are tracked in six degrees of freedom (6DOF)

- Fast, 3D tracking.
- Small, lightweight 6DOF sensors that can mounted on any probe.
- Multiple magnetic field transmitters (generators) for extended tracking ranges.
- Highly accurate real-time feedback on probe's position.

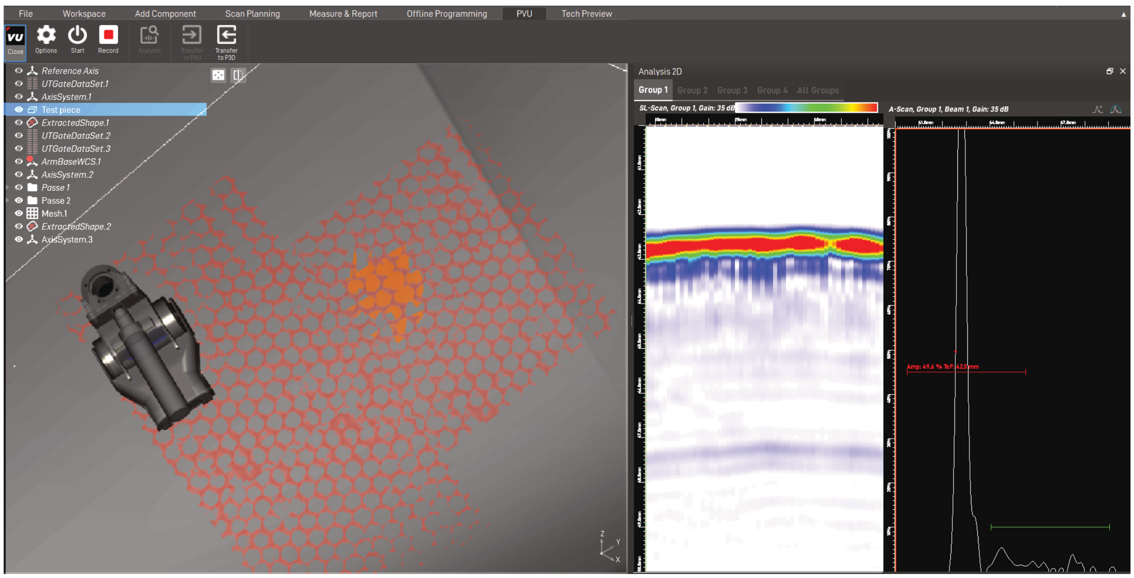
Software

Pragma3D is the software handling the live-feed of the probe's position and subsequent data mapping. A 3D model of the part is directly imported onto the work environment via a compatible CAD file or a laser scan generated with the RS5 scanner.

For calibration of the Axis system, a touch probe is used to acquire the position of three known references on the actual part. Upon calibration, it's absolutely required that the part or the arm isn't moved since that would compromise said calibration.

Data mapping in real time can be achieved with a fluid 3D representation of the probe movement and through the integration of PragmaVU, the software acquiring the ultrasonic data and feeding it to Pragma3D.

The result are unprecedented levels of Probability of Detection (PoD), and ensures maximum fidelity and traceability of all data. If required, the probe can be swapped for another with a different geometry or frequency to complete the acquisition, always under the same work project.



Conclusion

For the purpose of detecting outer skin disbonds, water ingress, crushed cores and water ingress, PAUT with a complete 6DOF encoding system was developed. Given the fact that honeycomb cores are essentially hollow, PAUT is essentially limited to the outer skin and the adhesive bond layer directly below it. No data is gathered from the inner skin and its bonding layer.

Using high frequency arrays, a fine and detailed map of the underlying honeycomb structure can be obtained, where crushed, warped and even water ingress can be detected.Positioning systems like the MagTracker, allow for an unprecedented level of freedom of movement, dispensing the typical rigid scanner or indexed single-line acquisitions. There are no physical constraints.

Ordering Info

SKU	Description
PRG-PRO-900	PragmaPro NDT Instrument Platform
PRG-PRO-KIT0	PragmaPro Convenience Kit
PRG-PAUT-32/128	PAUT 32/128 Cartridge
PRG-3D-COMP	Pragma3D | Composer, Data Acquisition and Analysis Software for Windows PC, Version 2.x, Free Updates and Support for 1 Year
PRG-PAUT-SPOT-20M121	PragmaSpot, Aqualene delay line, 20 MHz, 121 Elements, 11x11 Matrix
PRG-SCAN-CMM-ADAPT2	PragmaSpot Adaptor for CMM Arm

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