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NON-DESTRUCTIVE EVALUATION OF COMPOSITES

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INTRODUCTION

The composite materials have been used in aerospace industries for quite some time. Several non-destructive evaluation (NDE) methods have been developed to inspect composites in order to detect flaws, matrix cracking, and delamination. These methods include ultrasonics, acoustic emission, shearography, thermography, X-ray, and digital image correlation. The NDE Branch of Marshall Space Flight Center has recently acquired a thermal imaging NDE system. The same system has been used at NASA Langley Research Center for detecting disbonds [1,2].

In order to compare different NDE methods, three carbon/carbon composite panels were used for experiment using ultrasonic C-scan, shearography, and thermography methods. These panels have teflon inserts to simulate the delamination between plies in a composite panel. All three methods have sucessfully located the insert. The experiment and results are presented in the following sections.

EXPERIMENT

Three [0, +/-45, 90]s carbon/carbon composite panels with teflon inserts were used for this experiment. The size of each panel is 76 mm (3 inches) square. Each panel is fabricated with eight plies of standard T-300, 8 harness, satin weave carbon/carbon laminates which have a per ply thickness of 0.29 mm (0.0115 inches). Teflon inserts between two adjecent plies were used to simulate delamination in the composite panels. Three different configurations of inserts are listed in Table 1. The teflon tape insert is one half ply thick (0.145 mm, 0.00575 inches).

Table 1. Description of Sample Configurations

Sample #	Sample Code	Insert Size	Between Ply #
1	D7&8D1/4	6.35mm (0.25")	7 and 8
2	D7&8D1/2	12.7mm (0.5")	7 and 8
3	D6&7D1/2	12.7mm (0.5")	6 and 7

Ultrasonic C-Scan

A 20 MHz, 6.35 mm (0.25 inch) transducer was used to inspect sample #3 (12.7 mm square insert between 6th and 7th plies). The center area of 45.7 mm (1.8 inch) square was scanned with a rate of 12.7 mm (0.5 inches) per second. The telflon tape insert was detected. Efforts have also been made to determine the depth of the insert by locating the signals from the insert. However, the attempts were not

one of the surface.

Eletronic Laser Shearography

All three samples were evaluated by this method. The back surface (8th ply) of each panel was coated with white powder to eliminate the glare. Each panel was placed in front of the electronic shearography NDE system. A thermal couple was attached to the surface away from the camera. The laser speckle images were sheared in the horizontal (x) direction. The panel was then excited with a heat gun to raise the temperature of the surface to above 93 C (200 F). The shearograms produced clearly showed the locations of the inserts in terms of the variation of the fringe patterns at the center of each panel.

Thermogrphy

A halogen lamp was first used as the heat source. The results were not satisfactory. A heat gun was then used to provide a constant heat flux while the themal images were digitized by the thermal imaging system. The heat was transffered from the first ply surface to the eighth ply surface which was facing the camera. The digitized thermal images were carefuly studied. By selecting the proper median temperature and increments, the inserts appeared as dark areas at the center of each panel. An image analysis software was then used to enhance these images carbon/carbon composite panels with the teflon tape inserts provided samples for comparing these methods. All three methods could determine the locations of the inserts without difficulties. The ultrasonic and thermogrphy system could also identify the general shape of the inserts although the edges were not clear. The shearograams indicated the changes of the surface slopes. When the delamination occurs closer to the surface, the fringe patterns tend to become more complex due to the deformation of the thin laminate. Both shearography and thermography NDE systems are portable and easy to use. However, it requires training and experience to effectively use the systems for detecting flaws in materials.

ACKNOWLEDGMENT

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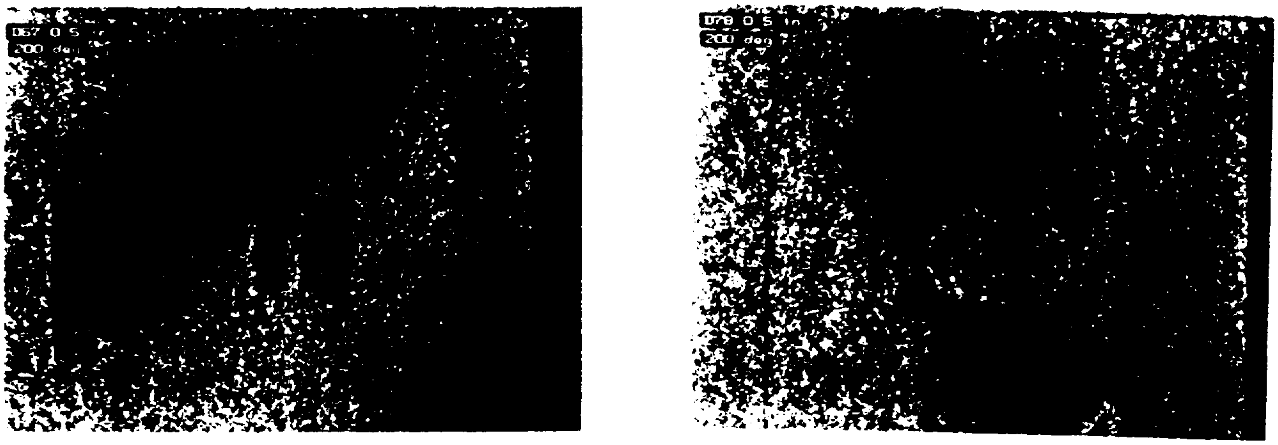
REFERENCES

1. W.P Winfree and P.H. James, "Thermographic Detection of Disbonds," *Proceedings of the 35th ISA International Instrumentation Symposium,* pp. 183-188, 1989.

2. W.P. Winfree, et. al., "Thermographic Detection of Disbonds in Rivetted Lap Joints," *Proceedings of the 37th ISA International Instrumentation Symposium,* pp. 1097-1105, 1991.


Scan Limits XYZR Turntable Go Quit
Begin C Scan
(Scanner)



D6&7D1/2 D7&8D1/2

Figure 2. Shearograms Showing the Simulated Delaminations

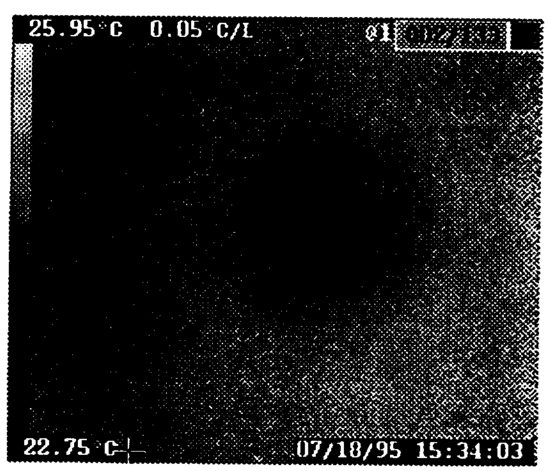


Figure 3. Thermal Image of Sample D7&8D1/2