NASA TECH BRIEF

Nondestructive Testing Techniques Used in Analysis of Honeycomb Structure Bond Strength

A research study was conducted to discover a means of detecting disbonds in composite structures. A portable, nondestructive testing and scanning/recording system, using ultrasonic techniques, was desired that would operate from one side only of a honeycomb panel to facilitate detection of the disbonds.

From theoretical and test data, a relationship was established between bond strength and the vibratory response of face sheets of honeycomb composite panels. Valid parameters were determined for the ultrasonic measurements of the bond strength of organic adhesives.

From this information, various methods of bond strength determination were proposed, of which the DOT (Driver-Displacement Oriented Transducer) method appears most applicable to both the lap shear type application and the honeycomb sandwich structures. This automatic inspection system, incorporating an electromagnetic driver and a displacement measuring system into a single unit, measures the displacement of the honeycomb composite face sheet at a given resonant frequency. The system has the distinct advantage of providing noncontact bond strength measurements. All tests measured the adhesive bond damping from the near side. Four types of honeycomb composite structures were fabricated to provide reference standards for evaluating both the ultrasonic techniques and the scanning/recording system. Deliberate disbonds, in the shape of triangles or squares, were located at predetermined interfaces on the honeycomb panels.

Based on the results of a comprehensive literature survey, five basic ultrasonic techniques were chosen as potential solutions for the honeycomb composite inspection problem. To evaluate these techniques, five breadboard systems were developed and tested: pulse echo interference, impedance, decrement, spectrum analysis, and intermodulation. The impedance system showed the most promise, and further development resulted in the successful detection and recording of disbonds in the specimens. Destructive tests were performed to verify the indicated disbonds.

A number of semiautomated scanning/recording systems were developed to supplement the ultrasonic technique evaluation. An advanced, fully automated, system was integrated with the ultrasonic detection system. This combined system (the DOT method) was characterized for transducer and circuit specifications, and operating instructions were prepared.

Notes:

1. The system allows remote testing of large surfaces with minimum surface disturbance, and should be of interest to industries engaged in nondestructive testing.
2. The research study report includes preparation of the composite specimens, equipment specifications, nondestructive test technique evaluations, development and characterization of the impedance system, determination of adhesive bond strength, conclusions, recommendations and references. A literature and industrial survey, including international publications, commercial equipment suppliers, and scientific and technical organizations, was conducted to maintain an awareness of current developments. Copies of this report are available from:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B67-10574

(continued overleaf)

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: John F. Moore, Gordon Thomas, Donald C. Erdman, George Martin, and Harold S. Varney
of North American Aviation, Inc.
under contract to
Marshall Space Flight Center
(MFS-1214 and 1221)