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NASA TECH BRIEF



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Instrumentation for Nondestructive Testing of Composite Honeycomb Materials

A program was conducted to develop (1) instrumentation for nondestructive testing (NDT) of adhesive-bond strength in honeycomb materials and (2) air-coupled inspection methods suitable for large tankage. From the analytical and experimental work, a relationship was found between the variation in viscoelastic properties of an adhesive and the cohesive bond strength of the adhesive. From the adhesive damping data it was predicted that the vibrational response amplitude would decrease with elevated temperatures, and the relaxation character of the degraded adhesive would show a small activation energy.

Two experimental test systems were constructed. In the Displacement Oriented Transducer (DOT) system, vibrations are excited by an eddy current coil, and deflections are measured with a photometric device. The other system, based on a Laval nozzle siren, is designed to provide mechanical vibrations for nonmetallic materials. Analysis of the DOT vibration measurements verified that the damping of the adhesive is related to the cohesive bond strength by either the internal friction at the fundamental and harmonic frequencies or the relative vibration-response peak amplitudes. Amplitude-response data are consistent with the mathematical analysis, show good correlation with cohesive bond strength, and are in general agreement with the predicted damping theory and adhesive-property tests. Thus, the DOT approach was shown to be a practical method of nondestructively determining cohesive bond strength.

The development of a nondestructive test system for measuring adhesive damping was directed toward

a high-energy excitation-detection transducer system for one-side bond-strength measurements. A pneumatic-type exciter that was developed is capable of producing air bursts up to 20,000 pulses per second with forces of 0.1 to 0.3 pound. Two air-pulse designs were completed and a laboratory test model was fabricated using a Laval nozzle to produce a supersonic air flow to be chopped at a selectable frequency by a rotary disk containing a series of peripheral holes. The air pulser was evaluated as an alternate driver for bond-strength measurements and proved sufficient for the required high-level excitation; however, more satisfactory results were obtained in terms of control and noise level using electromagnetic excitation.

Measurements on composite specimens at various temperatures show a frequency-internal friction relationship which clearly indicates differences in cohesive bond strength. The internal friction data at some frequency-temperature conditions show the practicality of go no-go indications and at other frequency-temperature conditions indicate a quantitative means of determining bond strength.

Notes:

1. Earlier work in this program is summarized in NASA Tech Brief 67-10574.
2. Documentation is available from:
Clearinghouse for Federal Scientific
and Technical Information
Springfield, Virginia 22151
Price \$3.00
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(continued overleaf)

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No patent action is contemplated by NASA.

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