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NASA TECH BRIEF

Nondestructive Determination of Cohesive Strength of Adhesive-Bonded Composites

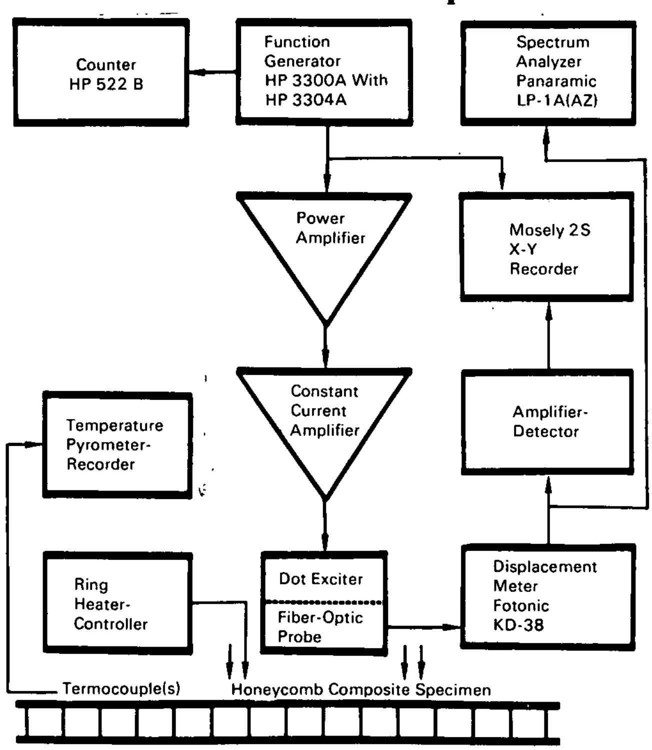

Fig. 1. Block Diagram of the DOT System

The problem:

Development of a nondestructive method for determining the bond strength of adhesive-bonded honeycomb composites.

The solution:

A novel method is based on the fact that the strength is a function of the vibration-damping properties of the bond. It may interest builders of aircraft or ships. A systematic plan was evolved to (1) determine the fundamental and harmonic vibration responses and modes of honeycomb composites at ambient temperature and as a function of temperature; (2) correlate the vibrational responses of composite specimens varying in the strength of the cohesive bond; (3) determine the effect of variation in thickness of the face sheet over the test range of frequency; (4) optimize the characteristics of the excitation transducer, and evaluate self-heating capabilities; and (5) design a system for measurement of bond strength.

This study has led to development of the Displacement-Oriented Transducer (DOT) System for measurement of bond strength. This system is basically a vibration-analysis method; it produces high-level, automatically variable-frequency, excitation forces in a

(continued overleaf)

metallic structure, detects microinch displacements produced in the structure, and provides output signals suitable for recording of responses (fig. 1).

The excitation circuit comprises an automatic swept-frequency source and power amplifier driving an electromagnetic transducer. Excitation levels range up to 15 A at 30 V over the range in frequency from 0.01 to 10 kHz. An operational amplifier compares the input signal with a feedback signal, proportional to the transducer current, for correction of coil-impedance changes and for ensurance of constant-current drive over the range of operational frequency.

The system for detecting vibration-response uses a commercial fiber-optic displacement instrument sensitive to displacement by 5 microinches (1.27×10^{-5} m) over frequencies ranging from direct current to 40 kHz. The fiber-optic probe is accurately positioned coaxially in the excitation transducer. The displacement instrument is modified to provide an amplified and demodulated ac output proportional to the measured dynamic displacement amplitude. The displacement signals may be monitored on a cathode-ray spectrum analyzer and/or plotted on an x-y recorder as a function of the excitation frequency (fig. 2). The system is capable of automatic recording of the dynamic frequency response of the structure.

How it's done:

Operation of the DOT System is based on an initial calibration from measurements of response from composite materials whose strength properties are known. From these data the system can be calibrated in terms of bond-strength deviation from a calibration standard, in terms of measurement of resonance-response amplitude, frequency, or half-bandwidth. The displacement-oriented transducer can be operated either noncontact or supported on the composite with variously sized rings or with three-point contacts. The material under test is swept-frequency driven at selected levels of excitation until a resonance response is indicated. Particular frequency resonances related to the geometry effects of the test system are ascertained, and only the resonances associated with the damping of the composite are measured.

An attempt has been made to relate curing temperature to the determined bond strength of the adhesive. Exact correlation between the DOT System method and tensile-testing procedures has not been found.

Note:

Documentation is available from:
Clearinghouse for Federal Scientific and Technical Information
Springfield, Virginia 22151
Price $3.00
Reference: TSP69-10464

Patent status:

No patent action is contemplated by NASA.

Source: D. O. Thompson of North American Rockwell Corporation under contract to Marshall Space Flight Center (MFS-20397)

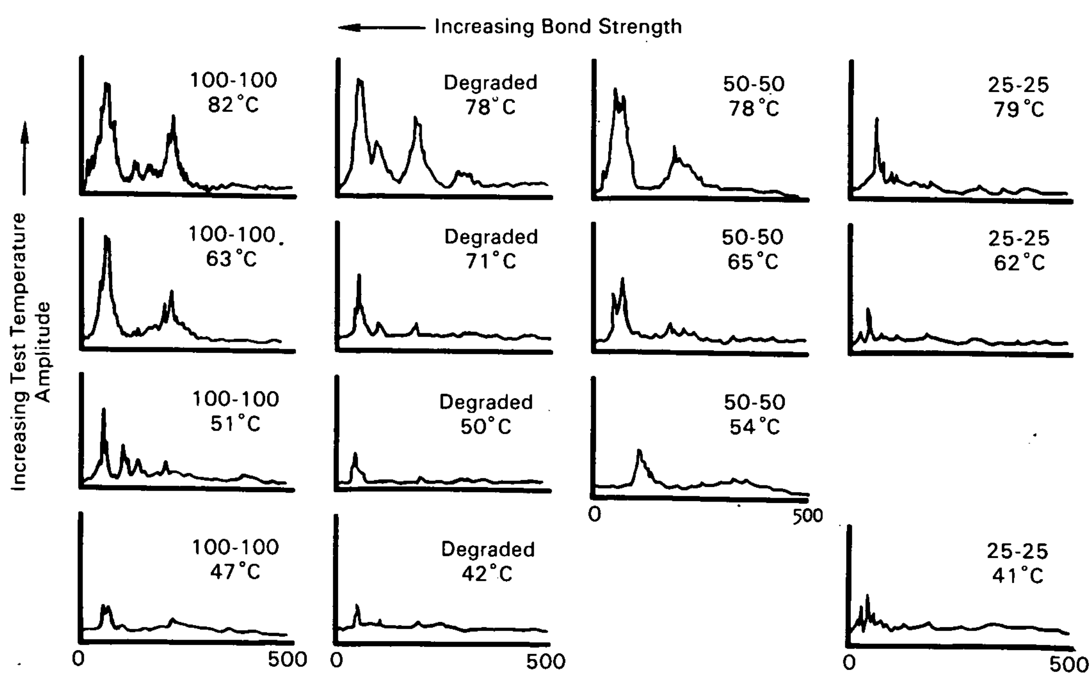

Fig. 2. Low-Frequency-Response Waveforms for Various Bond Strengths and Test Temperatures