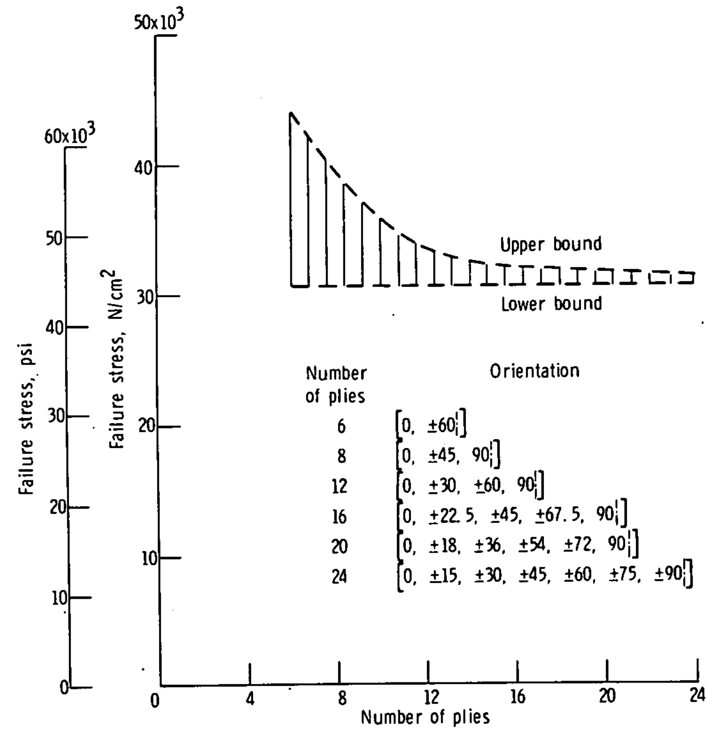
March 1973 B73-10039

NASA TECH BRIEF

Lewis Research Center

AN INEXPENSIVE AND EFFECTIVE METHOD FOR CALCULATING THE STRENGTH OF RANDOMLY REINFORCED FIBER COMPOSITES



Upper and lower bounds for strength of various pseudoisotropic composites from Modmor-I/epoxy at 0.50 fiber volume content with zero voids and no residual stress.

The Problem:

Planar randomly reinforced fiber composites (PRRFC) can be made from any combination of a large number of available fibers and matrices. Selecting the most suitable combination for a given application usually leads to a time consuming and costly series of screening tests. An analytical procedure to determine the strength of PRRFC can serve as an effective and inexpensive means in selecting suitable fiber/matrix combinations for specific designs.

The Solution:

It has recently been demonstrated that the well-known laminate theory can be applied to determine the strength of PRRFC. A PRRFC is, in essence, a pseudoisotropic laminate with a large number of ply orientation combinations where the strength is a function of these ply orientation combinations. The strength of the pseudoisotropic laminate, and thus the strength of PRRFC, can be predicted using laminate theory.

(continued overleaf)

How It's Done:

Laminate theory is used to demonstrate numerically that the minimum strength of a pseudoisotropic laminate is independent of the number of ply orientation combinations. The upper bound on the strength of a pseudoisotropic laminate approaches the lower bound of its strength as the number of ply orientation combinations increases (see figure). Since a PRRFC is a pseudoisotropic laminate with a large number of ply orientation combinations and since the maximum strength of the pseudoisotropic laminate approaches its minimum strength as the number of ply orientation combinations increases, it follows that the strength of the PRRFC is equal to the minimum strength of the pseudoisotropic laminate. This establishes the validity for using pseudoisotropic laminate analogy to predict the strength of PRRFC.

Notes:

1. The simplest pseudoisotropic laminate which possesses bending symmetry suffices for strength predictions of PRRFC. One such laminate consists of the following ply orientation (0°, +45°, -45°, 90°, 90°, -45°, +45°, 0°).
2. Laminate theory in conjunction with composite micro- and macromechanics can be used to predict mechanical properties of PRRFC's with any fiber/matrix combination. This procedure can also be used to investigate the effects of processing variables, such as cure temperature and void content, on the PRRFC strength.
3. The pseudoisotropic laminate analogy applies to both fiber/metallic and fiber/nonmetallic matrix composites.
4. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference: NASA TN-D-6696 (N72-18582), Design Properties of Randomly Reinforced Fiber Composites
5. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B73-10039

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