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FATIGUE PROPERTIES OF 8 OZ-8 SHAFT "E"
FIBER GLASS SATIN REINFORCED EPOXIES
AND POLYESTERS

by

A. E. SLOBODZINSKI

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DEPARTMENT OF DEFENSE
PLASTICS TECHNICAL EVALUATION CENTER
PICATINNY ARSENAL, DOVER, N. J.

PLASTICS TECHNICAL EVALUATION CENTER
PICATINNY ARSENAL, DOVER, NEW JERSEY 07801

PLASTEC 24651



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SUMMARY

The search was limited to current commercially available resins and prepregs. Data on an epoxy fiberglass system available only on special order from the 3M Company is included in Appendix C. However the special order is not commercially produced.

Not counting the special system, the data on Volan-finished 181 type, E fiberglass satin reinforced plastics are contained in 3 U.S. reports. The limited data indicates that the laminates laid up of Ferro E293/7781-550 prepreg afford the promise of sustaining the severest fatigue conditions.

On the other hand, two Japanese papers on polyester fiberglass indicate favorable fatigue resistance as well. In these cases, the compositions and the finishes on the fiberglass are locally unknown.

It is recommended that the "B" value for fatigue strength of E293/7781-550 laminates containing a nominal 50% volume content of reinforcement will exceed 12,000 psi when tested in a marine environment for 10^7 of $R = -1$ cycles. It is also recommended that design values for the fan duct in the subject surface effect vessel should be determined from tests more closely simulating the anticipated use conditions. Results of narrow coupon tests do not necessarily correlate with the design criteria.



RESULTS OF LITERATURE SEARCH

The published fatigue data on commercially available "Volan finished" satin "E" fiberglass fabric reinforced polyesters and epoxies are the following:

1. Boller, K.H., "Fatigue Tests of Glass Fabric Base Laminates Subjected to Axial Loading," FPL Report 1823, May 1952 and Reaffirmed August 1958
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2. Boller, K.H., "Supplement to Fatigue Tests of Glass Fabric Base Laminates Subjected to Axial Loading," FPL Report 1823A and Reaffirmed May 1960.

Results on two polyester matrix laminates are contained in the report and its supplement. The press was used to impregnate the dry layups of 181-114 (Volan) fiberglass fabric. Both compositions were press-cured at 220°F to 250°F and 13 psi for two hours.

One laminate contained the resin formulation whose constituent weight fractions were the following.

- Alkyd styrene 98.4%
- Tricresyl phosphate 0.8%
- Benzoyl peroxide 0.8%

The laminate attained a stiffness of 2.54×10^6 psi and a fatigue strength at 10^7 cycles of reversed stress of 8.75 KSI. It is presumed locally that the composite will sustain 1/3% fully reversed constant strain for 10^7 cycles.

The other laminate contained the substitution of diallyl phthalate alkyd for the alkyd styrene in the formulation for the matrix. The second laminate attained a stiffness of 2.74×10^6 psi and a fatigue strength at 10^7 cycles of reversed stress of 7 KSI. It is similarly presumed that the laminate will sustain about 1/4% reversed strain for 10^7 cycles.

3. Conn, Andrew F.; Rudy, S. Lee; and Howard, Stephan C.; "Flexural Fatigue and Cavitation Erosion of Glass Reinforced Plastic Composites." Prepared for Surface Effect Ships Project Office (PM-17) Contract No. I35535 Amendments 1-5. Hydronautics, Inc. Tech Report 7244-4, Jan 1974.

This report contains the evaluations of 3 polyester fiberglass composites and two epoxy fiberglass laminates which were fatigued in flexure while immersed in sea water. All laminates were reinforced by 7781-550 (DuPont's improved Volan) fiberglass fabric. While all the polyester laminates sustained drastic loss of stiffness when subjected to 0.6% reversed flexure strain to 10^4 cycles, the epoxies sustained negligible or no loss of stiffness.