Contrails

WADC TECHNICAL REPORT 52-183
SUPPLEMENT VI
ASTIA DOCUMENT NO. 203784

ANNUAL REPORT ON RESEARCH FOR USE IN ANC-17 HANDBOOK "PLASTICS FOR FLIGHT VEHICLES"

DONALD G. COLEMAN
FOREST PRODUCTS LABORATORY

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MATERIALS LABORATORY
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PROJECT NO. 7340

WRIGHT AIR DEVELOPMENT CENTER
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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FOREWORD

This report was prepared by the U. S. Forest Products Laboratory under USAF Contract No. AF 33(616)-56-9. This contract was initiated under Project No. 7340, "Rubber, Plastic, and Composite Materials," Task No. 73400, "Structural Plastics". It was administered under the direction of the Materials Laboratory, Directorate of Laboratories, Wright Air Development Center, with Mr. W. E. Dirkes acting as project engineer.

This report covers work conducted from July 1957 to July 1958.

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ABSTRACT

Developments in the program of research in plastics for flight vehicles conducted by the U. S. Forest Products Laboratory during fiscal year 1958 are summarized. The approach has been in general to derive criteria mathematically and then to check by test. Three technical reports issued during the fiscal year are abstracted.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

R. T. Schwartz

R. T. SCHWARTZ
Chief, Organic Materials Branch
Materials Laboratory

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TABLE OF CONTENTS

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Contrails

INTRODUCTION[1]

This annual report by the U. S. Forest Products Laboratory covers developments in the program of research in plastics for flight vehicles conducted during fiscal year 1958. For information on previous work in related programs, see WADC Technical Report 52-183, and supplements 1 through 5 for fiscal years 1952 through 1957.

Item 55-4.--Effect of Tensile Preloading and Water Immersion on Flexural Properties of Glass-Fabric Polyester Laminates

Tests of reinforced-plastic laminates are characteristically made on laminates that have not been previously stressed. Studies have shown that tensile stresses may cause crazing of the resin. Such crazing, and possibly other structural changes within the laminate, could result in paths along which moisture might penetrate. This might result in lower wet strength properties and less resistance to weathering than are observed from tests of laminates that have not been stressed previously. A previous Laboratory report, No. 1856, presented data showing that preloading produced statistically significant effects on most flexural properties, but the effect was so small as to be of little or no practical significance.

A supplementary report, No. 1856-A, was prepared to show the effect of prestressing on the weathering resistance. The results of the tests did not show any significant effect on flexural strength properties, although increasing levels of tensile prestressing did result in pronounced increases in the size of the crazing checks observed after 3 months and 1 year of weathering.

This item is now complete.

Item 56-1.--Creep of Glass-Fabric-Base Plastic Laminates

While creep parallel and perpendicular to the warp and fill directions of parallel and cross laminates is usually negligible, creep at other angles may be appreciable. Tensile creep and creep-rupture data were obtained for typical polyester and epoxy laminates including tests at 45° to the warp direction. The data are presented in Laboratory Report No. 1863. Creep at 45° loading was as much as 6 times greater than creep strains at 0° loading.

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[1] Manuscript released by author August 1958 for publication as a WADC Technical Report.

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This item is now complete.

Item 57-1. --Revision of ANC-17 Handbook

Work was continued on the revision of the ANC-17 Handbook pertaining to reinforced plastics. The second draft was revised in accordance with comments from members of the Defense Department and additional data were incorporated. A preliminary copy of the revised draft is now being typed for submission to members of the aircraft industry.

It is expected that the final printing of this revision will be done by the Government Printing Office.

Item 57-3. --Effect of Thickness of Laminates

Mechanical properties of reinforced plastics are generally evaluated by testing material 1/8 to 1/4 inch thick. Currently available data from several investigations indicate that many of these properties decrease markedly when the thickness is reduced to less than 1/16 inch; however, some data show the opposite effects. Furthermore, there is apparently a reduction in some strength properties when laminates become thick.

The effect of thickness on strength properties is of sufficient magnitude to warrant a detailed investigation of the thickness effect on laminates. Epoxy laminates of thicknesses from 0.02 to 1-1/2 inches and silicone laminates of thicknesses from 0.02 to 0.8 inch have been fabricated and will be tested. Work is also planned on the thickness effects in phenolic laminates.

Item 57-4. --Effect of Tensile or Compressive Preloading on the Tensile and Compressive Properties of a Typical Epoxy Laminate

Previous data have shown that tensile preloading will affect the tensile properties of polyester laminates (Laboratory Reports No. 1811 and 1811-A). However, data were also needed to determine the effects of preloading on properties of epoxy laminates so this item was set up.

All of the tests of the epoxy laminates planned under this item have now been completed and the data are being analyzed.

Item 57-5. --Effect of notches on Fatigue Strength of Epoxy Laminates

Available data have indicated that reinforced plastics are not nearly so sensitive to external stress risers as are many other materials. Axial fatigue

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tests of unnotched and notched specimens, where the notch was a centrally drilled hole, showed that the notch caused some reduction in fatigue strength, but not to the extent that might be expected. Recently, additional tests were made to evaluate the effect of different types of notches on the tensile strength. The results showed that some types of notches or cutouts result in more serious stress concentrations than a circular hole. Limited fatigue tests also showed that certain types of notches can cause a substantial reduction in fatigue strength. A report on this work is being prepared.

Item 57-6. --Design Data for a Silicone Laminate

Basic mechanical properties of polyester, phenolic, and epoxy laminates at room temperature are presented in Laboratory Reports No. 1820, 1820-A, 1820-B, and 1820-C. Similar data were obtained for a typical silicone laminate and the results are presented in Report No. 1820-D.

This item is now complete.

Item 57-7. --Survey on Filament Winding

The process of filament winding, as applied to reinforced plastic structures, has certain advantages that can, under certain conditions, result in a highly desirable structural product. Various organizations engaged in work on filament winding were contacted by letter to obtain information on the fabrication and design of such laminates. The results of the survey were compiled in a report for the use in evaluating needs for further research in this field.

This item is now complete.

Item 58-1. --Effect of Thermal Gradient on Strength Properties of Reinforced Plastic Laminates

Data are available on the effect of constant temperature and time at temperature on the strength properties of heat-resistant laminates. Information is also needed on the thermal gradient that exists, and its effect on strength properties, when two sides of a laminate are subjected to widely different temperatures. Limited work was done toward the development of techniques that could be used for determining these data.

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REPORTS OF RESEARCH IN PLASTICS FOR FLIGHT VEHICLES ISSUED BY U. S. FOREST PRODUCTS LABORATORY DURING FISCAL YEAR 1958

FPL Report No.	Title
1856-A	Supplement to Effects of Tensile Preloading and Water Immersion on Flexural Properties of a Polyester Laminate.
	Presents results of limited flexural tests of 181-glass fabric polyester laminates that had been prestressed in tension or various levels and subsequently weathered outdoors for 3 months to 1 year. Data supplement those of Report No. 1856.
1863	Tensile Stress-Rupture and Creep Characteristics of Two-Glass-Fabric-Base Plastic Laminates.
	Presents stress-rupture and strain-time relationships obtained from tests up to 1,000 hours of a typical polyester and epoxy laminate. Formulas for expressing stress-rupture and strain-time relationships are suggested.
1820-D	Supplement to Mechanical Properties of Plastic Laminates.
	Presents results of tension, compression, and flexural tests of a parallel-laminated silicone laminate reinforced with 181 glass fabric. Tests were made at room temperature.

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