

# **SUPPLEMENT TO FATIGUE TESTS OF GLASS-FABRIC-BASE LAMINATES SUBJECTED TO AXIAL LOADING**

**Information Reviewed and Reaffirmed**

**May 1960**

**No. 1823-A**



**FOREST PRODUCTS LABORATORY  
MADISON 5, WISCONSIN**

**UNITED STATES DEPARTMENT OF AGRICULTURE  
FOREST SERVICE**

**In Cooperation with the University of Wisconsin**

LAMINATES SUBJECTED TO AXIAL LOADING<sup>1</sup>

By

K. H. BOLLER, Engineer

Forest Products Laboratory,<sup>2</sup> Forest Service  
U. S. Department of Agriculture

-----  
Introduction

This report has been prepared as a supplement to Forest Products Laboratory Report No. 1823, "Fatigue Tests of Glass-Fabric-Base Laminates Subjected to Axial Loading." It presents a correlation of the fatigue data in the basic report with stress-rupture data on the same material reported in Forest Products Laboratory Report No. 1839, "Stress-Rupture Tests of a Glass-Fabric-Base Plastic Laminate."

The basic report presents the fatigue properties of three types of glass-fabric-base plastic laminates at room temperature. S-N curves between 1 thousand and 10 million cycles show the fatigue strength and the effect of various factors on the fatigue strength. One of these factors was the effect of three mean stresses on the duration of various alternating stresses. This effect was determined for only one of the three laminates at mean stresses of zero, one-half, and one-fifth of the static ultimate tensile stress. The data are presented in table 10 and figures 30 and 31 of Report No. 1823. It should be noted that these curves (the solid lines) were established from test values of alternating stress amplitude at the indicated number of cycles and at the three mean stress levels.

---

<sup>1</sup>-This progress report is one of a series prepared and distributed by the Forest Products Laboratory under U. S. Navy Bureau of Aeronautics Order No. NAer 01531 and USAF Delivery Order No. DO(33-616)53-20. Results here reported are preliminary and may be revised as additional data become available.

<sup>2</sup>-Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

However, no data were available to form a basis of projection of these curves (broken line) from the last point at 50 percent mean stress to the base line, which is the zero alternating stress, normally called steady stress. Since stress-rupture data were lacking, the curves were projected to the ultimate tensile stress.

Report No. 1839 shows the relation of various levels of steady stress with time. The data in this report show that the maximum tensile stress that can be sustained for a period of time is less than the static tensile strength. With this relationship now available, the fatigue data may be correlated with the values of steady stress vs. time. The correlation may be accomplished by using values of steady stress, which can be sustained for periods corresponding to the duration of the appropriate number of cycles, as the terminus of the curves on figures 30 and 31 of Report No. 1823.

### Revision

New values of mean tensile stress for various cycles at zero alternating stress were obtained from figures 6 and 7 of Report No. 1839 to produce a revision of figures 30 and 31 of Report No. 1823. The revised figures 30 and 31 are presented in this supplementary report. Since the fatigue testing machines were operated at 900 revolutions per minute, the times to impose  $10^3$ ,  $10^5$ , and  $10^7$  cycles of stress on a test specimen were 0.0185, 1.85, and 185 hours, respectively. Then the steady stresses that would cause failure at these 3 periods were obtained from the stress-rupture curves on figures 6 and 7. The time required for 1,000 cycles (0.0185 hours) is beyond the low limit of the stress-rupture curve; therefore, the curve was extended to 0.0185 hour and the stress values noted. The stress value noted for notched material, figure 7, was higher than the static tensile strength of the notched material. Therefore, the static tensile strength was used as the terminus of the  $10^3$  cycle curve of notched material.

The revised figures now show the relation between fatigue data and stress-rupture data. When a material is subjected to alternating stresses in fatigue studies, the life of the material depends on the value of the mean stress and the amplitude of the alternating stress. The information obtained from the stress-rupture tests is a special example of fatigue, that condition when the alternating stress is zero.

The results of endurance tests at room temperature of glass-fabric-base laminate having a polyester-type resin (resin 2) show that this material will endure 9,000 pounds per square inch of alternating stress amplitude for 10 million cycles (185 hours) at a zero mean tensile stress if the cyclic load frequency is 900 cycles per minute, or that it will endure 27,000 pounds per square inch of mean tensile stress for 185 hours at zero alternating stress amplitude.

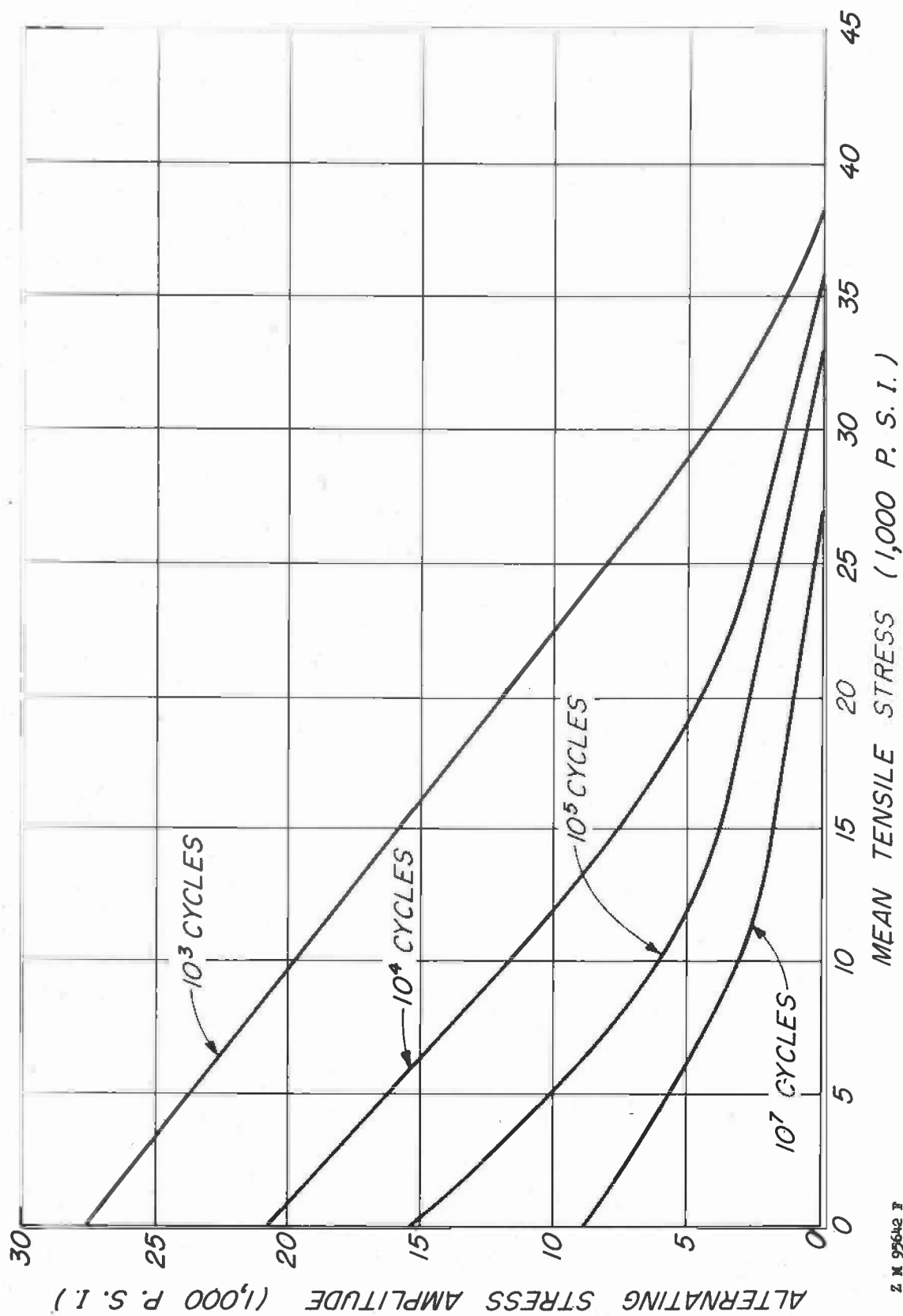


Figure 30. -- Effect of three mean stresses on alternating stress amplitude of an unnotched glass-fabric-base laminate (resin 2 + 181-114 fabric) in axial loading (revised).

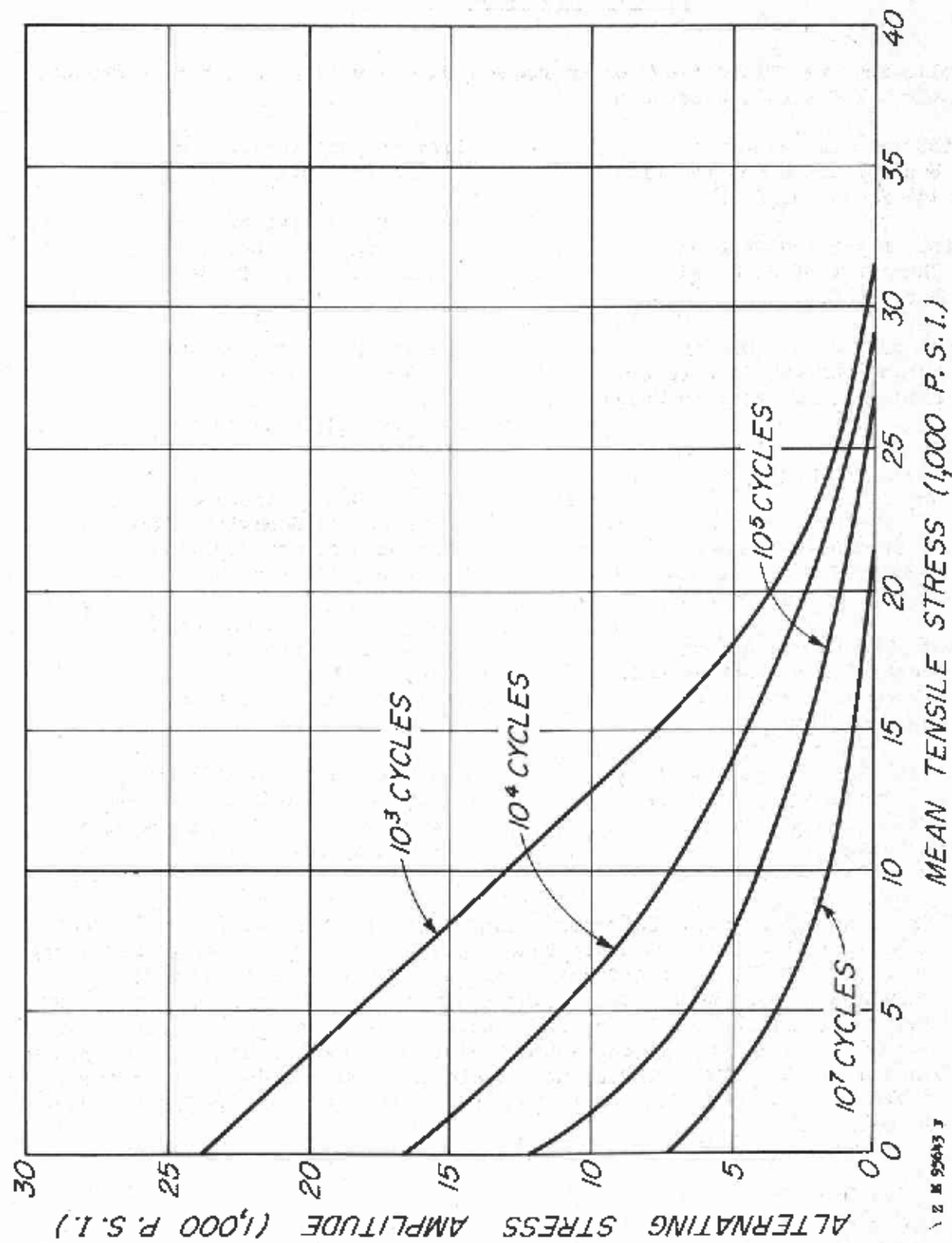


Figure 31. -- Effect of three mean stresses on alternating stress amplitude notched glass-fabric-base laminate (resin 2 + 181-114 fabric) in axial loading (revised).

SUBJECT LISTS OF PUBLICATIONS ISSUED BY THE  
FOREST PRODUCTS LABORATORY

The following are obtainable free on request from the Director, Forest Products Laboratory, Madison 5, Wisconsin:

List of publications on  
Box and Crate Construction  
and Packaging Data

List of publications on  
Chemistry of Wood and  
Derived Products

List of publications on  
Fungus Defects in Forest  
Products and Decay in Trees

List of publications on  
Glue, Glued Products  
and Veneer

List of publications on  
Growth, Structure, and  
Identification of Wood

List of publications on  
Mechanical Properties and  
Structural Uses of Wood  
and Wood Products

Partial list of publications  
for Architects, Builders,  
Engineers, and Retail  
Lumbermen

List of publications on  
Fire Protection

List of publications on  
Logging, Milling, and  
Utilization of Timber  
Products

List of publications on  
Pulp and Paper

List of publications on  
Seasoning of Wood

List of publications on  
Structural Sandwich, Plastic  
Laminates, and Wood-Base  
Aircraft Components

List of publications on  
Wood Finishing

List of publications on  
Wood Preservation

Partial list of publications  
for Furniture Manufacturers,  
Woodworkers and Teachers of  
Woodshop Practice

**Note:** Since Forest Products Laboratory publications are so varied in subject no single list is issued. Instead a list is made up for each Laboratory division. Twice a year, December 31 and June 30, a list is made up showing new reports for the previous six months. This is the only item sent regularly to the Laboratory's mailing list. Anyone who has asked for and received the proper subject lists and who has had his name placed on the mailing list can keep up to date on Forest Products Laboratory publications. Each subject list carries descriptions of all other subject lists.