Supplement to

EFFECTS OF TENSILE PRELOADING AND WATER

IMMERSION ON FLEXURAL PROPERTIES OF A POLYESTER LAMINATE

By

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Summary

This report presents the results of flexural tests on specimens taken from a 181 glass fabric polyester laminate and weathered at Madison, Wis., for 3 months or 1 year after various degrees of tensile preloading. The data supplement those of Forest Products Laboratory Report No. 1856, in which are presented results of flexural tests on matched specimens that were exposed, either while stressed or unstressed, to normal conditions or to various periods of water immersion.

The results of these limited tests did not indicate any significant effect of preloading on resistance to outdoor weathering. A pronounced increase in the size of crazing checks was observed after weathering, but this was of little or no practical significance as far as flexural properties of the laminate are concerned.

1This progress report is one of a series (ANC-17, Item 55-4) prepared and distributed by the Forest Products Laboratory under U. S. Navy, Bureau of Aeronautics No. NAer 01683 and U. S. Air Force No. Do 33(616)-53-20, Amendment A2(55-295). Results here reported are preliminary and may be revised as additional data become available.

2Maintained at Madison, Wis., in cooperation with the University of Wisconsin.
Introduction

The basic report\(^2\) presents data on the effects of various degrees of tensile preloading and subsequent water immersion on the flexural and water absorption properties of a 181 Volan A polyester laminate. That report indicated that additional testing of specimens from the same laminate was planned after the specimens had been exposed outdoors at Madison, Wis., for various lengths of time (series 3 tests). This report presents the results of flexural tests conducted on series 3 specimens weathered in the unstressed condition for either 3 months or 1 year.

The work was undertaken at the Forest Products Laboratory at the request of and in cooperation with the ANC-17 Panel on Plastics for Aircraft.

Experimental Procedure

Three flexural specimens were cut from each of the 20 preloaded strips of series 1 of the work. One specimen was assigned to each of three weathering times, 3 months, 1 year, and 3 years, thus providing five specimens at each of the four preload levels for each weathering period. The specimens were mounted in weathering racks and exposed outdoors in an unstressed condition at Madison, Wis. The exposed face of the specimens faced south and up at a 45° angle.

Specimens weathered for 3 months and for 1 year were removed from the weathering racks, reconditioned for at least 1 month at 75° F. and 50 percent relative humidity, and tested in flexure as described in the basic report, but with the weathered face downward (in tension). Specimens for 3-year weathering are still being exposed.

Presentation of Data

Table 2 presents average values of modulus of elasticity, proportional limit stress, and modulus of rupture of specimens at each preload level for specimens that were weathered for 3 months or 1 year. Also included are comparable data from table 1 of the basic report for specimens that were not weathered. The same data are presented graphically in figure 7 with least squares straight lines drawn to indicate the relationship to preload stress for each property after each weathering period.


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Discussion of Results

Table 2 and the curves of figure 7 show that the flexural properties of the weathered specimens were, in general, quite similar to those of matched unweathered specimens subjected to the same level of tensile preload.

Modulus of elasticity values for weathered material are higher at all levels of preload than those for unweathered material. All groups show a slight, but not significant, reduction in modulus of elasticity with increasing preload stress. The apparent difference in slopes of the lines indicating this reduction in figure 7 is too slight, in view of the observed variability of the test results, to indicate any real difference between the groups.

Values of proportional limit stress for material weathered 3 months are very nearly the same as those for unweathered material and show a slight increase with increasing preload stress. Values of proportional limit stress for material weathered 1 year show a reduction with increasing preload stress that is statistically significant but probably of no practical importance.

Modulus of rupture values for weathered material show a slightly greater reduction with increasing preload stress than do those for unweathered material. Both the differences in relationship to preload stress and the differences in actual value of the property, however, are too slight to be of any statistical or practical significance.

Crazing checks at the surface of weathered material were longer, wider, and deeper than those at the surface of unweathered material subjected to the same level of tensile preload. Weathered specimens that had not been preloaded were also characterized by pronounced crazing checks. Both of these effects were related to duration of weathering and were greater in material weathered 1 year than in material weathered 3 months.

Conclusions

The following conclusions may be drawn on the basis of observations and tests of flexural specimens from a 181 Volan A polyester laminate, after various tensile preloading and weathering at Madison, Wis.:

1. Crazing checks increased in size as a result of weathering.

2. The effect of tensile preloading on material weathered for periods up to 1 year is of little or no practical significance as far as flexural properties of the laminate are concerned.
Table 2.—Flexural properties of a 1"l Volan A polyester laminate after various degrees of tensile preloading and various durations of outdoor weathering. Each value is the average of five specimens.

<table>
<thead>
<tr>
<th>Preload stress</th>
<th>Flexure properties when weathered</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unweathered</td>
</tr>
<tr>
<td></td>
<td>P.s.i.</td>
</tr>
<tr>
<td>0</td>
<td>2,810</td>
</tr>
<tr>
<td>8,000</td>
<td>2,840</td>
</tr>
<tr>
<td>16,000</td>
<td>2,740</td>
</tr>
<tr>
<td>24,000</td>
<td>2,760</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>94</td>
</tr>
</tbody>
</table>
Figure 7. -- Relationship of flexural properties of 181 Volan A polyester laminate to preload stress after various periods of weathering. Each point is the average of five tests.