Report No. 8926-147

Material - Adhesives - Structural - EC 1660 and AF-32
(Minnesota Mining and Manufacturing Co.)

Skydrol 500 Hydraulic Fluid Resistance

A. F. Hooper, J. C. George, E. E. Keller

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Abstract:

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Title: MATERIAL - ADHESIVES - STRUCTURAL - EC 1660 and AF 32 (MINNESOTA MINING AND MANUFACTURING CO.). SKYDROL 500 HYDRAULIC FLUID RESISTANCE.

Authors: Hooper, A. F., George, J. C., Keller, E. E.
Report No.: 8926-147 Date: 11 February 1959
Contract: Model 22, Commercial
Contractor: General Dynamics/Convair

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4 pages, 2 tables.
REPORT NO. MP 58-465

SKYDROL 500 HYDRAULIC FLUID
RESISTANCE OF THE EC1660
ADHESIVE PRIME & AF 32
ADHESIVE BONDED JOINTS

MODEL: 22

PREPARED BY A. F. Hooper
GROUP Materials & Processes Lab.

CHECKED BY J. C. George
REFERENCE ____________

CHECKED BY E. E. Keller
APPROVED BY E. F. Strong, Chief
of Structures & Materials Lab.

NO. OF PAGES 4
NO. OF DIAGRAMS 2

REVISIONS

W. M. Luthardt, Grp. Engr.
INTRODUCTION:

Skydrol 500 hydraulic fluid, a phosphate ester fluid, has a high solvency power on many organic materials. Therefore, Engineering Design requested that test work be performed to determine the Skydrol 500 hydraulic fluid resistance of the AF 32 adhesive bonding system.

OBJECT:

To determine the Skydrol 500 hydraulic fluid resistance of the AF 32 adhesive bonded joints at ambient temperature.

CONCLUSION:

Skydrol 500 hydraulic fluid had no significant deleterious effects on the tensile shear and peel strength of the AF 32 adhesive bonded joints after 30 days immersion at ambient temperature.

TEST SPECIMENS:

Fifty-six (56) tensile shear test specimens were prepared in accordance with Convair Specification 22-00407, paragraph 3.5.1, using the AF 32 adhesive bonding system. Surfaces to be bonded were primed with EC1660.

Twenty-eight (28) peel strength test specimens were prepared in accordance with Convair Specification 22-00407, paragraph 3.5.1, using AF 32 adhesive bonding system. Surfaces to be bonded were primed with EC1660.

TEST PROCEDURE:

Twenty-eight (28) of the fifty-six (56) tensile shear test specimens were immersed in Skydrol 500 hydraulic fluid at ambient temperature. These tensile shear specimens were removed from Skydrol 500 hydraulic fluid in groups of four (4) after immersion. A group of specimens was removed from Skydrol 500 after 1, 5, 10, 15, 20, 25, and 30 days (s) and tested for tensile shear strength at ambient temperature. Duplicate groups of control specimens, which were not immersed, were also tested at 1, 5, 10, 15, 20, 25, and 30 days (s) with the immersed specimens.

Fourteen (14) of the twenty-eight (28) peel strength specimens were immersed in Skydrol 500 hydraulic fluid. These peel strength specimens were removed from Skydrol 500 hydraulic fluid in groups of two (2) after immersion. A group of specimens was removed after 1, 5, 10, 15, 20, 25, and 30 days (s) and tested for peel strength at ambient temperature. The peel strength of duplicate groups of controls, which were not immersed, were tested at 1, 5, 10, 15, 20, 25, and 30 days (s) with the immersed specimens.
RESULTS:

Skydrol 500 hydraulic fluid moderately softened the cured EC 1660 adhesive primer after 24 hours immersion.

The tensile shear and peel strength data for the AF 32 adhesive bonded system are tabulated in Tables I and II, respectively.

Skydrol 500 hydraulic fluid had no significant deleterious effects on the tensile shear and peel strengths of the AF 32 adhesive bonding system after 30 days immersion at ambient temperature. Skydrol 500 hydraulic fluid moderately softened the EC 1660 adhesive primer adjacent to the adhesive bonded joints. No softening of the EC 1660 adhesive primer was observed inside the glue line on bonded joints during the 30 day immersion period. The AF 32 adhesive bonded joints showed no evidence of Skydrol 500 hydraulic fluid penetration. Skydrol 500 hydraulic fluid plasticized the cured AF 32 tape flash after 5 days immersion.

DISCUSSION OF RESULTS:

The plasticization of the AF 32 tape flash could actually aid in dispersing the concentrated shear load away from the edge of the bonded joint. If Skydrol 500 hydraulic fluid had penetrated inside the glue line to any extent, it would have a deleterious effect on the load carrying capacity of the bonded joint. The tensile shear strengths of the test specimens are well above the 2500 psi. minimum values of the AF 32 adhesive bonded joints (MPS 47.16).

The test results indicate that AF 32 adhesive bonding system was not deleteriously affected by Skydrol 500 hydraulic fluid under the conditions tested.

NOTE: The data from which this report was prepared are recorded in Engineering Test Laboratory Data Book No. 984 and 3032.
### TABLE I - TENSILE SHEAR STRENGTH DATA (PSI)

**PERIODS OF IMMERSION IN SKYDROL 500**

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>1 day</th>
<th>5 days</th>
<th>10 days*</th>
<th>15 days*</th>
<th>20 days</th>
<th>25 days</th>
<th>30 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>44.70</td>
<td>40.50</td>
<td>43.20</td>
<td>44.80</td>
<td>38.00</td>
<td>46.00</td>
<td>44.50</td>
</tr>
<tr>
<td>2</td>
<td>45.50</td>
<td>41.50</td>
<td>45.60</td>
<td>41.60</td>
<td>39.00</td>
<td>40.50</td>
<td>45.00</td>
</tr>
<tr>
<td>3</td>
<td>45.00</td>
<td>36.00</td>
<td>46.40</td>
<td>42.40</td>
<td>38.50</td>
<td>45.00</td>
<td>43.00</td>
</tr>
<tr>
<td>4</td>
<td>44.00</td>
<td>42.50</td>
<td>40.80</td>
<td>44.80</td>
<td>38.00</td>
<td>43.00</td>
<td>42.50</td>
</tr>
</tbody>
</table>

**AVERAGE** 44.05 40.62 44.00 43.40 38.35 43.62 43.75

<table>
<thead>
<tr>
<th>Control Specimens No.</th>
<th>Not Immersed in Skydrol 500</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3900 4200 41.60 44.00 44.00 45.00 44.50</td>
</tr>
<tr>
<td>2</td>
<td>3950 4300 44.80 42.40 41.00 39.50 42.50</td>
</tr>
<tr>
<td>3</td>
<td>4200 4300 40.00 42.40 36.50 39.50 41.00</td>
</tr>
<tr>
<td>4</td>
<td>4400 4300 41.60 43.20 37.50 42.00 40.50</td>
</tr>
</tbody>
</table>

**AVERAGE** 41.12 42.75 42.00 43.00 39.75 41.50 41.62

* The 10 & 15 days tensile shear data above for the immersed and control specimens were recalculated upon recalibration of the testing machine which was found to be out of adjustment during testing during those periods.
ACCESS NO.

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4 pages, 2 tables.
<table>
<thead>
<tr>
<th>TABLE II - PEEL STRENGTH DATA (LBS/INCH WIDTH)</th>
<th></th>
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<tbody>
<tr>
<td>PERIODS OF IMMERSION IN SKYDROL 500</td>
<td></td>
</tr>
<tr>
<td>Specimen No.</td>
<td>1</td>
</tr>
<tr>
<td>5 days</td>
<td>44</td>
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<td>10 days</td>
<td>50</td>
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<tr>
<td>15 days</td>
<td>49</td>
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<td>20 days</td>
<td>44</td>
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<td>25 days</td>
<td>44</td>
</tr>
<tr>
<td>30 days</td>
<td>44</td>
</tr>
<tr>
<td>Control Specimen No.</td>
<td>1</td>
</tr>
<tr>
<td>Not Immersed in Skydrol 500</td>
<td>48</td>
</tr>
</tbody>
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