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MODEL XD-36

DATE May 5, 1944
Test No. 551

FORT WORTH REPORT
No. FW-TSG-43

TITLE STRINGER AND SKIN SPLICE TESTS XD-36 OUTER WING
LOWER SURFACE

SUBMITTED UNDER Development Laboratories

PREPARED BY: M. Parsh

GROUP: Structures Test

REFERENCE:

CHECKED BY: G. O. Kenyon

APPROVED BY: H. C. Foyvey

NO. OF PAGES: 20

NO. OF DIAGRAMS

REVISIONS

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C. R. Irwins
### Summary

<table>
<thead>
<tr>
<th>Spec. No.</th>
<th>Specimen Description</th>
<th>Design Load</th>
<th>Ultimate Load</th>
<th>% D. L.</th>
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<tbody>
<tr>
<td>551-1</td>
<td>P. S. 47015 Inner to Outer Panel Stringer &amp; Skin Tension Splice (Sta. 23)</td>
<td>164,800#</td>
<td>168,400#</td>
<td>102%</td>
</tr>
<tr>
<td>551-2</td>
<td>P. S. 47010 - #1 Typical Skin Splice (Sta. 20)</td>
<td>151,500#</td>
<td>151,500#</td>
<td>100%</td>
</tr>
<tr>
<td>551-3</td>
<td>P. S. 47010 - #2 Same as P. S. 47010 - #1 Except for the addition of twelve Monel Rivets replacing Dural</td>
<td>131,500#</td>
<td>147,800#</td>
<td>112%</td>
</tr>
<tr>
<td>551-4</td>
<td>P. S. 47005 - #1 2&quot; x .125 Z Stringer Spliced to a 2&quot; x .102 Z Stringer</td>
<td>53,300#</td>
<td>60,600#</td>
<td>114%</td>
</tr>
<tr>
<td>551-5</td>
<td>P. S. 47005 - #2 2&quot; x .091 Z Stringer Spliced to a 1&quot; x .064 Z Stringer</td>
<td>30,700#</td>
<td>35,250#</td>
<td>115%</td>
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</tbody>
</table>
CONSOLIDATED VULTEE AIRCRAFT COPR., FORT WORTH DIV.,
TEX. (REPORT NO. DEVF 275-551)

STRINGER AND SKIN SPLICE TESTS XB-36 OUTER WING,
LOWER SURFACE - FORT WORTH REPORT NO. FM-TSG 41

N. BARSH 5 MAY 44 28PP PHOTOS, DIAGRAMS, GRAPHS, DRWG

STRUCTURES(?) WINGS - STRUCTURAL TESTS
DESIGN AND DETAILS(?) B-36 - STRUCTURAL TESTS
B-36

CLASSIFIED
REFERENCES

PHOTOGRAPHS:

No. 114364 - View Showing Bending of Skin and Doubler at 100% Design Load (Specimen 551-1).

No. 114369 - Front View of Failure (Specimen 551-1).

No. 114367 - Rear View of Failure (Specimen 551-1).

No. 114244 - Front View of Skin Splice (Specimen 551-2) in 200,000# Test Machine.

No. 114245 - Rear View of Skin Splice (Specimen 551-2) in Test Machine.

No. 114246 - Front and Side View of Skin Splice (Specimen 551-2) Showing Failure and Bending of Skin and Doubler.

No. 114243 - Rear View of Skin Splice (Specimen 551-2) Showing Failure of Splice Rivets.

No. 114256 - Front View of Failure of Skin Splice (Specimen 551-3).

No. 114257 - Rear View of Failure of Skin Splice (Specimen 551-3).

No. 114200 - Front View of Stringer Splice (Specimen 551-4) in Test Machine Showing Failure.

No. 114201 - Closeup Showing Front and Side View of Stringer Splice (Specimen 551-4) Failure.
REFERENCES (contd.)

PHOTOGRAPHS: (contd.)

No. 114203 - View Showing Set-Up and Failure of Stringer Splice (Specimen 551-5).
No. 114202 - Side and Front View of Stringer Splice (Specimen 551-5) Showing Failure.

REFERENCES ONLY:

Specimen Project Slips - No. 47015
No. 47010
No. 47005

Test Project Slips - No. 44213
No. 44215
<table>
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<tr>
<th>Test No.</th>
<th>551</th>
<th>Fort Worth Report No.</th>
<th>FW-FSG 45</th>
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<tr>
<td>Analysis</td>
<td>CONSOLIDATED VULTEE AIRCRAFT CORPORATION</td>
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<tr>
<td>Prepared by</td>
<td>A.N. PAREKH</td>
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<tr>
<td>Development Engineering Group</td>
<td>VULTEE FIELD, CALIFORNIA U.S.A.</td>
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### TABLE

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<thead>
<tr>
<th>Specimen</th>
<th>Design Load Ultimate Load</th>
<th>Failure</th>
<th>% Designed Failure</th>
<th>Description of Failure</th>
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<tbody>
<tr>
<td>551-1</td>
<td>165,400</td>
<td>131,500</td>
<td>100%</td>
<td>in tension at splice. (See Photos: #114256, Page 22.)</td>
</tr>
<tr>
<td>551-2</td>
<td>165,400</td>
<td>131,500</td>
<td>100%</td>
<td>in tension at splice. (See Photos: #114256, Page 22.)</td>
</tr>
<tr>
<td>551-3</td>
<td>165,400</td>
<td>147,800</td>
<td>112%</td>
<td>in tension at splice. (See Photos: #114256, Page 22.)</td>
</tr>
<tr>
<td>551-4</td>
<td>165,400</td>
<td>60,800</td>
<td>42%</td>
<td>The stringers failed in tension at splice. The skin failed in tension at splice. (See Photos: #114256, Page 22.)</td>
</tr>
<tr>
<td>551-5</td>
<td>165,400</td>
<td>35,200</td>
<td>25%</td>
<td>Skin and stringer failed in tension at splice. (See Photos: #114202, Page 29.)</td>
</tr>
</tbody>
</table>

For distribution of stress at various strain gage locations for the different specimens, see Curves, Pages 11, 12, 13, 14 and 15. Strain gage data is available in test files.
DISCUSSION:

It is believed that Specimen 551-2 failed in the following manner:

At high loads a definite "rocking" motion of the splice rivets permitted the skin to slip. This condition, while relieving the skin, allowed an increasing amount of the load to pass to the stringer. Ultimate failure, however, was caused by a complete transfer of load to the stringer, following a shear failure of the splice rivets.

Specimen 551-3 was able to accept a greater load than Specimen 551-2 because of the increased number of monel rivets at the splice. By replacing twelve (12) of the 1/4 in. diameter 17ST rivets with 1/4 in. diameter monel rivets, the slipping effect of the skin was retarded, thus enabling the skin to carry more load than it did in Specimen 551-2. In this Specimen, failure of the skin was accompanied (followed) by the tension failure of the skin, the monel rivets holding though severely deformed.

Specimen 551-1, which was similar in construction to Specimens 551-2 and 551-3, failed in a manner similar to Specimen 551-3. In this Specimen, 1/4 in. monel rivets were used almost exclusively. Rocking action and deformation of the skin splice rivets was also noted in this Specimen, although it was not as prominent as it was in Specimens 551-2 and 551-3.

Eccentric loading of the skin and doublers at the splice was noted in Specimens 551-1, 551-2 and 551-3. Strain gages #1, 4 and 7 on doublers read compression during the entire loading. (See Photographs No. 114364, Page 17, and No. 114246, Page 22.)

Bending action was also noted in the stringers of all specimens, as can be seen by comparing the stresses at the extreme fibres and legs of the Zee sections (See Curves, Pages 11 to 18, inclusive).
PROCEDURE:

Seventeen strain gages were located at different points (See Sketch, Page 8) on Specimens 551-1, 551-2 and 551-3. Strain gage readings were taken at a number of load increments up to 100% design load, after which the specimens were loaded to failure.

Strain gage readings were also taken for the twelve gages on Specimens 551-4 and 551-5 (See Sketch, Page 10) for a number of load increments up to 100% design load. After reaching 100% design load, holes were drilled in a line across the Specimen's skin so as to simulate actual conditions on the wing where the ribs framed into the skin. The Specimens were then loaded to failure.

Design load was calculated on the basis of 50,000 psi over the minimum gross cross-sectional area of the Specimen.

CONCLUSION:

All Specimens tested were satisfactory.

Inasmuch as Specimen 551-2 failed after holding 100% design load for only two minutes, it was found necessary to replace some of the 1/4 in. diameter 17ST rivets with 1/4 in. diameter monel rivets in the splice of Specimen 551-3 so as to reduce the rocking effect of the rivets and the slippage of the skin. Specimen 551-3 was warranted in preference to Specimen 551-2 because it failed at 112% design load.
LOCATION OF STRAIN GAGES

SPEC. 551-4

SPEC. 551-5
Curves showing stresses at various stoping class locations.
Curves showing stresses at various gage locations.
CURVES SHOWING STRESS AT VARIOUS
STRAIN GAGE LOCATIONS

Stress (kips per ft)

Gage I

Gage II

Average of Gage I & Gage II

Percent Design Load
PHOTOGRAPH NO. 114364

VIEW SHOWING SENDING OF SKIN AND DOUBLERS AT 100% D. L.

(SPECIMEN 551-1)
PHOTOGRAPH NO. 14246

SIDE VIEW OF SHEAR TEST (SHEAR NO 661-2) IN
test machine.
PHOTOGRAPH NO. 114843

REAR VIEW OF SKIN SPLICE SPECIMEN (551-2) SHOWING

FAILURE OF SPLICE RIVETS
PHOTOGRAPH NO. 114257

NEAR VIEW OF FAILURE OF SKIN SPLICE (SPECIMEN 551-3)
PHOTOGRAPH NO. 114200

FRONT VIEW OF STRINGER SPLICE (SPECIMEN 551-4)

IN TEST MACHINE SHOWING FAILURE
PHOTOGRAPH NO. 114201

CLOSEUP SHOWING FRONT AND SIDE VIEW OF STRINGER SPACES

(SPECIMEN 551-4) FAILURE
Fort Worth Report
311.15-150.49

(STRUCTURE - 1.5)
PHOTOGRAPH NO. 114202

SIDE AND FRONT VIEW OF STRINGER SPLICE (SPECIMEN 551-5) SHOWING FAILURE
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STRINGER AND SKIN SPlice TESTS XB-36 OUTER WING, LOWER SURFACE - FORT WORTH REPORT NO. FW-FSG 43

B. BARSH 5 MAY 44 28PP PHOTOS, DIAGRS, GRAPHS, DRWG

STRUCTURES (7) WINGS - STRUCTURAL TESTS
DESIGN AND DETAILS (3) B-36 - STRUCTURAL TESTS

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