63-3-2

351 770

GD

GENERAL DYNAMICS | CONVAIR

(Report No. 8926-142)

Report on Material - Steel, Alloy, 4340 - Aluminum, 2024-T3 and 7075-T6

Effect of Surface Finishes on Fatigue Life.

by E. K. Winslow, G. D. Lindeneau, and W. E. Wise,

9 March 1959

12p. incl. illus tables, 3 refs.

Published and Distributed
under
Contract AF33(657)-8926

NA

Post Office Box 1950, San Diego 12, California 296-6611
Material Post Office Box 2071 273-8000 | Accounting Post Office Box 510

#1.60

Report No, 8926-142

Material - Steel, Alloy, 4340 - Aluminum, 2024-T3
and 7075-T6

Effect of Surface Finishes on Fatigue Life

Abstract:

Fatigue tests of 7075-T6 bare aluminum alloy in the as received condition, and 4340 steel in the machined, heat treated (280,000 to 300,000 psi ultimate tensile strength) and stress relieved condition showed that micro-glass peening promoted greater fatigue life than did vapor blasting. Fatigue life comparisons with the bare 2024-T3 aluminum alloy showed that machining did not result in change but chemical milling did, and micro-glass peening served to restore and improve the fatigue life of chemically milled surfaces.

Reference: Winslow, E. K., Lindeneau, G. D., Wise, W. E., "Micro-Glass-Peening 2024-T3 Aluminum, 7075-T6 Aluminum, and 4340 Steel, Bending Fatigue," General Dynamics/ Convair Report SL 58-154, San Diego, California, 9 March 1959. (Reference Attached).

ACCESS NO.

Title: MATERIAL - STEEL, ALLOY, 4340, - ALUMINUM, 2024-T3 and 7075-T6. EFFECT OF SURFACE FINISHES ON FATIGUE LIFE.

Authors: Winslow, E. K., Lindeneau, G. D., Wise, W. E.
Report No.: 8926-142 Date: 9 March 1959
Contract No.: P.E.A. 7028
Contractor: General Dynamics/Convair
ABSTRACT: Fatigue tests of 7075-T6 bare aluminum alloy in the as received condition, and 4340 steel in the machined, heat treated (280,000 to 300,000 psi ultimate tensile strength) and stress relieved condition showed that micro-glass peening promoted greater fatigue life than did vapor blasting. Fatigue life comparisons with the bare 2024-T3 aluminum alloy showed that machining did not result in change but chemical milling did, and micro-glass peening served to restore and improve the fatigue life of chemically milled surfaces.

12 pages, 3 tables, 2 figures, 3 references.

STRUCTURES & MATERIALS LABORATORIES

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION

SAN DIEGO

REPORT SL58-154

DATE 9 March 1959

MODEL R & D (7028)

TITLE

REPORT NO. SL58-154
MICRO-GLASS-PEENING
2024-T3 ALUMINUM, 7075-T6 ALUMINUM,
AND 4340 STEEL
BENDING FATIGUE
MODEL R & D
(7028)

PREPARED BY E.K. Winslow
E.K. Winslow
G. D. Lindeneau
G. D. Lindeneau

GROUP STRUCTURES LABORATORIES

REFERENCE

CHECKED BY E.S. W. E. Wise
W. E. Wise

APPROVED BY E. F. Strong
E. F. Strong
Chief of Structures and
Materials Laboratories

WITNESS:
R. A. Miller

NO. OF PAGES 12

NO. OF DIAGRAMS 6

REVISIONS

NO.	DATE	BY	CHANGE	PAGES AFFECTED
ee				

FORM 1812 A-4

INTRODUCTION:

Micro-glass-peening is similar to shot peening except glass beads are used in place of metal shot. Shot peening is established as a process which improves the fatigue life of a metal. Micro-glass-peening needs to be established as a process for fatigue life improvement.

OBJECT:

a. To find the effect of micro-glass-peening as compared to vapor blasting on the fatigue life of 7075-T6 bare aluminum alloy and 4340 steel, heat treated to 280,000 to 300,000 psi.

b. To find the effect of the following processes on the fatigue life of 2024-T3 bare aluminum alloy:

1. Machining
2. Chemically removing surface.
3. Chemically removed surface micro-glass-peened.

CONCLUSIONS:

a. Micro-glass-peening produced a greater increase in the fatigue life of both the 7075-T3 bare aluminum alloy and the 4340 steel than did vapor blasting.

b. The effect of the processes on the fatigue life of 2024-T3 bare aluminum alloy was as follows:

1. Machining did not change the fatigue life.
2. Chemically removing the surface decreased the fatigue life slightly.
3. Micro-glass-peening of the chemically removed surface increased the fatigue life to a marked degree.

RECOMMENDATIONS:

The optimum bead size, peening intensity, and time duration of peening needed to obtain the best fatigue life in a given material should be determined.

TEST SPECIMENS:

The test specimen configurations for each of the three materials are the same except for thickness as shown in Figure 1.

a. 7075-T6 Aluminum Alloy and 4340 Steel

1. 7075-T6 Aluminum Alloy

All specimens were taken from the same sheet of 1/4 inch thickness material. The specimens were processed to three conditions as follows:

1. As received.
2. Vapor blasted.
3. Micro-glass-peened.

No. 625 grit was used in vapor blasting. The specimens were blasted for 39 sec./sq. inch of surface. The grit size and time duration of blasting were determined from data given in Convair Report No. 9353, page 6.

No. 15 STD-AL glass beads (a Skyway Metal Processing Company designation) were used for micro-glass-peening. Four specimens were peened with uniform coverage for forty-five seconds with an Almen intensity of .008. Two specimens were peened for ninety seconds and two specimens for twenty-two seconds, all at an Almen intensity of .006.

Surface roughness of the three groups was as follows:

1. As received, 15 micro-inches.
2. Vapor blasted, 12 micro-inches.
3. Micro-glass-peened, 75 micro-inches.

2. 4340 Steel

Steel specimens machined to 1/4 inch thickness were heat treated to 280,000 - 300,000 psi in the same heat. The scale on the specimens was removed by sand blasting. The specimens were stress-relieved to eliminate the effects of blasting. The Rockwell reading of the specimens was 54C to 57C. The steel specimens were then processed to three conditions as follows:

TEST SPECIMENS: (Continued)

a. 7075-T6 Aluminum Alloy and 4340 Steel (Con't)

2. 4340 Steel (Con't)

1. Machined, heat treated, and stress relieved.
2. Condition 1, plus vapor blast.
3. Condition 1, plus micro-glass-peening.

The specimens were vapor blasted for the same time and with the same size grit as for the 7075-T6 aluminum alloy. The grit size and time duration were also determined from Convair Report No. 9353.

The micro-glass-peened specimens were peened with No. 15 STD-STL glass beads. Data on the intensity are not available. Four specimens were peened for ninety seconds with uniform coverage over the entire specimen. Two specimens were peened for one hundred-eighty seconds and two specimens for forty-five seconds.

The surface roughness of the three specimens types was as follows:

1. Machined, heat treated, and stress relieved - 65 micro-inches.
2. Condition 1, vapor blasted - 57 micro-inches.
3. Condition, micro-glass-peened - 45 micro-inches.

b. 2024-T3 Bare Aluminum Alloy

All specimens were taken from the same plate of 3/8 inch thickness material. The specimens were then processed to the following conditions:

1. As received - 3/8 inch thickness.
2. Machined to .250 inch thickness.
3. Chemical removal of surface to .250 inch thickness.
4. Condition 3, plus micro-glass-peening.

Data were not available on the glass bead size or peening intensity. Four specimens were peened with uniform coverage for thirty seconds. Two specimens were peened for sixty seconds and two specimens were peened for twenty seconds.

TEST SPECIMENS: (Continued)

b. 2024-T3 Bare Aluminum Alloy (Continued)

The surface roughness of the four groups was as follows:

1. As received - 9 micro-inches.
2. Machined - 13 micro-inches.
3. Chemically removed surface - 160 micro-inches.
4. Chemically removed surface plus micro-glass-peening - 165 micro-inches.

The micro-glass-peening was done by the Skyway Metal Processing Company of Sun Valley, California.

TEST PROCEDURE AND RESULTS:

All specimens were fatigue tested in a Sonntag SF-1U fatigue machine. The test set up is shown in Figure 2.

a. 7075-T6 Bare Aluminum Alloy and 4340 Steel

1. 7075-T6 Bare Aluminum Alloy

These specimens were tested at a maximum stress of 35,000 psi with a stress ratio of -1. The fatigue test results are given in Table I.

2. 4340 Steel

The steel specimens were tested at 130,000 psi maximum stress with a stress ratio of -1. The test results are given in Table II.

b. 2024-T3 Bare Aluminum Alloy

These specimens were tested at a maximum stress of 30,000 psi with a stress ratio of -1. The test results are given in Table III.

DISCUSSION OF RESULTS:

a. 7075-T6 Bare Aluminum Alloy and 4340 Steel

1. 7075-T6 Bare Aluminum Alloy

Micro-glass-peening increased the fatigue life of the material. Vapor blasting also increased the fatigue life of the material. The peening produced a greater increase in life than did the vapor blasting.

DISCUSSION OF RESULTS: (Continued)

a. 7075-T6 Bare Aluminum Alloy and 4340 Steel (Con't)

2. 4340 Steel

Vapor blasting increased the fatigue life of the material. The test scatter was as follows: maximum life, 670,000 cycles - minimum life 68,000 cycles. Micro-glass-peening also increased the fatigue life. The test scatter was as follows: maximum life, 493,000 cycles - minimum life, 192,000 cycles. On the basis of test scatter, the micro-glass-peening produced a greater increase in fatigue life than did the vapor blasting.

b. 2024-T3 Bare Aluminum Alloy

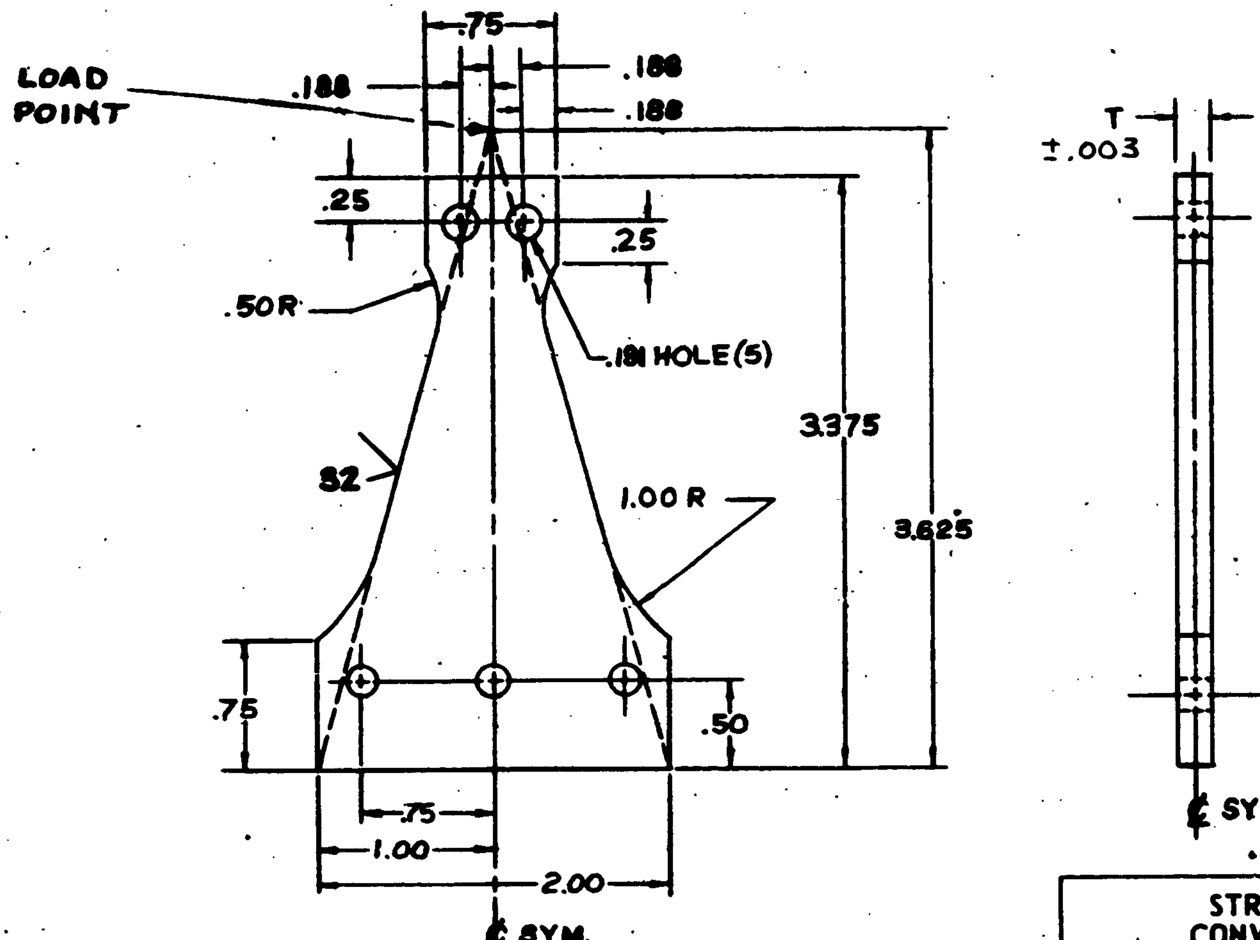
Machining the material did not change the fatigue life. Chemically removing the surface decreased the fatigue life. Micro-glass-peening the chemically removed surface increased the fatigue life to a marked degree.

On the basis of test results given in Convair Reports 56-166 and 56-215, chemical removal of surface in the manufacture of parts should be used with caution when fatigue strength is important. Micro-glass-peening offers a solution for the fatigue strength problem as does shot peening on the basis of these tests.

In the micro-glass-peened specimen groups, different times of peening were used as shown in the test specimen section and in the tables of results. These groups with two specimens indicate that the time duration of peening is important in the effect the peening has on the fatigue life; however, no conclusion was drawn, due to the limited number of specimens in each group.

NOTE:

The data from which this report was prepared are recorded in Structures Test Laboratory Data Book No. 4066, pages 77-99.



QUAN. REQ.	MAT'L	T
	7075-T6	.250
	4340	.250
	2024-T3	.375
	2024-T3	.250

NOTES:
1. THERE ARE TO BE NO NICKS, SCRATCHES, OR UNDERCUTS IN TEST SECTION.
2. DO NOT GRIND
3. UNLESS OTHERWISE SPECIFIED TOLERANCES ARE AS FOLLOWS: LINEAR DIM. .XX - ±.03 .XXX - ±.010 ANGULAR DIM. - 0°30'
4. MATERIAL TO BE AS SPECIFIED.
5. GRAIN DIRECT. TO BE LONGIT. UNLESS OTHERWISE SPECIFIED

A

STRUCTURAL TEST
CONVAIR - SAN DIEGO
A DIVISION OF GENERAL DYNAMICS

TITLE
STANDARD FATIGUE SPECIMEN
UNNOTCHED-SHEET BENDING

MODEL	SCALE	DATE	DRAWN BY
	FULL	1-16-57	BRIGHT

S.O.
W.O.
DRAWING NUMBER 10030

FIGURE 1.

6-899

CONVAIR SD - 3213

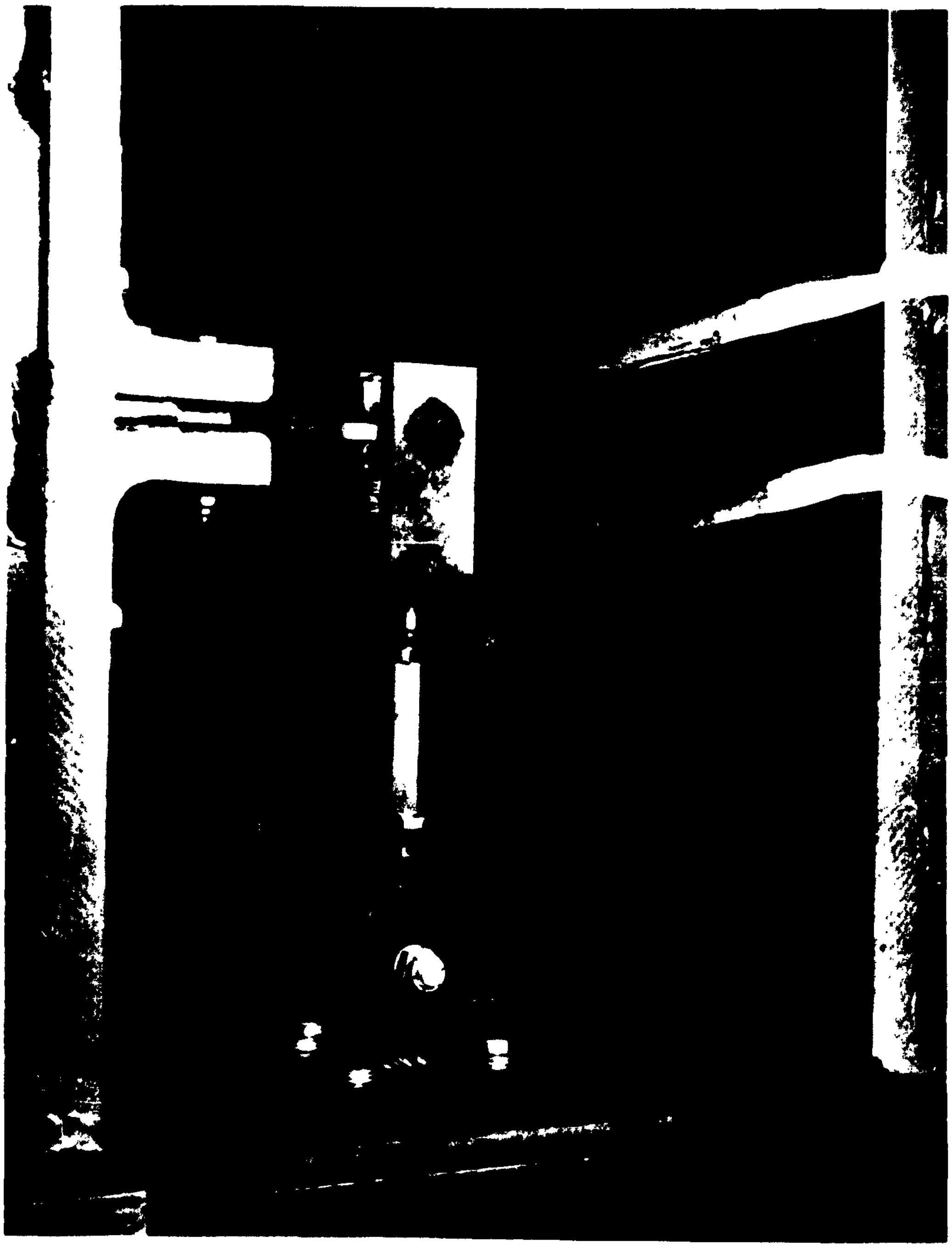


Figure 2 FATIGUE TEST SET-UP

TABLE I

FATIGUE TEST RESULTS- 7075-T6 BARE ALUMINUM ALLOY

SPECIMEN NUMBER	CONDITION	MAXIMUM STRESS	STRESS RATIO	FATIGUE LIFE CYCLES
75-9	AS RECEIVED	35,000	-1.0	92,000
75-10				82,000
75-11				106,000
75-12	AS RECEIVED	35,000	-1.0	88,000
75-4	VAPOR BLASTED	35,000	-1.0	299,000
75-5				377,000
75-6	VAPOR BLASTED	35,000	-1.0	344,000
75-13	MICRO PEENED - 45 SEC.	35000	-1.0	569,000
75-14				501,000
75-15				496,000
75-16	MICRO PEENED - 45 SEC.	35000	-1.0	472,000
75-17	MICRO PEENED - 22 SEC.	35,000	-1.0	505,000
75-18	MICRO PEENED - 22 SEC	35,000	-1.0	711,000
75-19	MICRO PEENED - 90 SEC	35,000	-1.0	694,000
75-20	MICRO PEENED - 90 SEC	35,000	-1.0	523,000

TABLE II

FATIGUE TEST RESULTS – 4340 STEEL

SPECIMEN NUMBER	CONDITION	MAXIMUM STRESS	STRESS RATIO	FATIGUE LIFE CYCLES
4340-10	*	130,000	-1.0	61,000
4340-14	↕	↕	↕	66,000
4340-18	↕	↕	↕	65,000
4340-19	*	130,000	-1.0	93,000
4340-2	VAPOR BLASTED	130,000	-1.0	447,000
4340-7	↕	↕	↕	588,000
4340-13	↕	↕	↕	68,000
4340-16	VAPOR BLASTED	130,000	-1.0	670,000
4340-5	MICRO PEENED – 90 SEC.	130,000	-1.0	493,000
4340-6	↕	↕	↕	192,000
4340-8	↕	↕	↕	230,000
4340-11	MICRO PEENED – 90 SEC	130,000	-1.0	405,000
4340-12	MICRO PEENED – 45 SEC.	130,000	-1.0	133,000
4340-15	MICRO PEENED – 45 SEC.	130,000	-1.0	1,259,000
4340-17	MICRO PEENED – 180 SEC.	130,000	-1.0	345,000
4340-20	MICRO PEENED – 180 SEC.	130,000	-1.0	247,000

NOTES:

* MACHINED, H.T. 289000 TO 309000 PSI. STRESS RELIEVED.

TABLE III

FATIGUE TEST RESULTS- 2024-T3 BARE ALUMINUM

SPECIMEN NUMBER	CONDITION	MAXIMUM STRESS	STRESS RATIO	FATIGUE LIFE CYCLES
2024-2	AS RECEIVED	30,000	-1.0	108,000
2024-3	↕	↕	↕	143,000
2024-4	↕	↕	↕	175,000
2024-6	AS RECEIVED	30,000	-1.0	237,000
2024M-1	MACHINED	30,000	-1.0	190,000
2024M-2	↕	↕	↕	198,000
2024M-3	↕	↕	↕	150,000
2024M-5	MACHINED	30,000	-1.0	123,000
2024C-9	CHEMICAL REMOVAL OF SURFACE	30,000	-1.0	174,000
2024C-10	↕	↕	↕	167,000
2024C-11	↕	↕	↕	162,000
2024C-12	CHEMICAL REMOVAL OF SURFACE	30,000	-1.0	103,000

TABLE III CONT'D.

FATIGUE TEST RESULTS - 2024-T3 BARE ALUMINUM

SPECIMEN NUMBER	CONDITION	MAXIMUM STRESS	STRESS RATIO	FATIGUE LIFE CYCLES
2024C-1	CHEM. REMOVAL OF SURFACE - MICRO PEENED 30 SEC.	30,000	-1.0	785,000
2024C-2	↕	↕	↕	954,000
* 2024C-3	↕	↕	↕	*1,000,000
2024C-4	CHEM REMOVAL OF SURFACE - MICRO PEENED 30 SEC.	30,000	-1.0	913,000
2024-5	CHEM. REMOVAL OF SURFACE - MICRO PEENED 60 SEC.	30,000	-1.0	837,000
2024-6	CHEM REMOVAL OF SURFACE - MICRO PEENED 60 SEC.	30,000	-1.0	1,095,000
2024-7	CHEM. REMOVAL OF SURFACE - MICRO PEENED 20 SEC.	30,000	-1.0	805,000
2024-8	CHEM. REMOVAL OF SURFACE - MICRO PEENED 20 SEC.	30,000	-1.0	864,000

NOTES
*- NO FAILURE

REFERENCES

1. Matera, T. A., "Evaluation of Effect of Vapor Blasting on Fatigue Life", Convair Report No. 9353, page 6, dated 19 January 1956.

2. Sherman, R. A. , "Chemically Milled Aluminum Alloys Mechanical Properties and Fatigue Tests", Convair Report No. 56-166, dated 10 August 1956.

3. Sherman, R. A. , "Chemical Mill Evaluation and Qualification Tests", Convair Report No. 56-215, dated 3 May 1957.