

NATIONAL BUREAU OF STANDARDS REPORT

10 086

Progress Report
on
**TEST METHODS FOR EVALUATING THE STRESS
CORROSION BEHAVIOR OF ALUMINUM ALLOYS**

To
Materials Division
Naval Air Systems Command
Department of the Navy



U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

NATIONAL BUREAU OF STANDARDS

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NBS PROJECT

3120410

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**TEST METHODS FOR EVALUATING THE STRESS
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To
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U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

Progress Report
on
Test Methods for Evaluating the Stress
Corrosion Behavior of Aluminum Alloys

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Engineering Metallurgy Section

Results to date in an investigation comparing test methods used for evaluating the stress-corrosion behavior of aluminum alloys (authorized under RRMA 2123) are included herein.

Test methods studied in this investigation are the constant strain method and the constant load method for applying stress to the specimens.

The aluminum alloys used for test specimens in these studies include the following:

2219-T352 aluminum alloy hand forging
(10 in. thick).

2219-T852 aluminum alloy hand forging
(10 in. thick).

2219-T62 aluminum alloy sheet (0.064
in. thick).

7079-T651 aluminum alloy rolled plate
(6 in. thick).

The tests are being conducted in the marine atmosphere at Kure Beach, N. C. (80 ft. lot) and in the laboratory at the National Bureau of Standards, Washington, D. C., and at the Alcoa Research Laboratories, New Kensington, Pennsylvania. Tables 1, 2, and 3 contain the results obtained to date from tests conducted in these environments.

These tests are continuing.

Table 1. Results obtained from stress-corrosion tests conducted in the marine atmosphere at Kure Beach, N.C. (80 ft. lot)

| Exposure Stress, Percent of Yield Strength | Constant Strain Method | | | | Constant Load Method | | |
|---|------------------------|---------------------|----------------------------------|---------|----------------------|---------------------|----------------------------------|
| | F/N (a) | Days to Failure (b) | Percent Loss in Tensile Strength | Remarks | F/N (a) | Days to Failure (b) | Percent Loss in Tensile Strength |
| <u>2219-T352 Aluminum Alloy Hand Forging (10 in. Thick), Short Transverse^(h)</u> | | | | | | | |
| 75 | 2/3 | 42, 58 | - | (c) | 3/3 | 9, 9, 9 | - |
| 50 | 3/3 | 58, 76, 113 | - | | 3/3 | 13, 14, 23 | - |
| 0 | 0/3 | Rem 26, 135 | 25, 26 | (c) | 0/2 | Rem 13, 23 | 9, 15 |
| <u>2219-T852 Aluminum Alloy Hand Forging (10 in. Thick), Short Transverse^(h)</u> | | | | | | | |
| 75 | 1/3 | 888 | - | (d) | 0/3 | 414(3) NF | 13, 14, 15 |
| 0 | 0/3 | Rem 888 | (i) | (d) | 0/3 | Rem 414(3) | 10, 11, 15 |
| <u>2219-T62 Aluminum Alloy Sheet (0.064 in. Thick), Transverse^(h)</u> | | | | | | | |
| Preform ^(f) | 0/3 | - | - | (e) | No Specimens Exposed | | |
| 75 | 0/3 | - | - | (e) | 0/3 | 414(3) NF | 6, 7, 8 |
| 0 | 0/3 | - | - | (e) | 0/3 | Rem 414(3) | 7, 8, 9 |
| <u>7079-T651 Aluminum Alloy Rolled Plate (6 in. Thick), Short Transverse^(h)</u> | | | | | | | |
| 25 | 3/3 | 259, 545, 1144 | - | | 3/3 | 24, 31, 31 | - |
| 15 | 0/3 | - | - | (e) | 3/3 | 24, 29, 82 | - |
| 0 | 0/3 | - | - | (e) | 0/3 | Rem 24, 29, 82 | 5, 6, 22 |
| <u>7079-T651 Aluminum Alloy Rolled Plate (6 in. Thick), Long Transverse^(h)</u> | | | | | | | |
| 75 | 3/3 | 58(2), 85 | - | | 0/3 | 29, 36, 37 | - |
| 0 | 0/3 | Rem 135, 267(2) | 6, 7, 8 | | 0/3 | Rem 29, 36, 37 | 3, (g), 4 |

- (a) F-Number of specimens that failed.
N-Number of specimens exposed
- (b) Rem - Unstressed specimens removed from test after exposure for number of days shown.
NF - Stressed specimens had not failed after exposure for number of days shown.
Numbers in parentheses refer to number of specimens.
- (c) One specimen still on exposure; Total exposure time to Sept. 1, 1969 - 1600 days.
- (d) Two specimens still on exposure; Total exposure time to Sept. 1, 1969 - 1600 days.
- (e) Three specimens still on exposure; Total exposure time to Sept. 1, 1969 - 1600 days.
- (f) Preform - Specimen deformed to introduce residual stresses and then additionally stressed by constant strain method.
- (g) Specimen broke while removing it from test.
- (h) Principal axis of the specimen with respect to the direction of working.
- (i) Data not available.



Table 2. Results obtained from stress-corrosion tests conducted in an artificial laboratory environment (aqueous solution containing 3.5% NaCl - intermittent immersion).

| Exposure Stress, Percent of Yield Strength | Constant Strain Method* | | | Remarks | Constant Load Method | | |
|--|-------------------------|---------------------------|--|---------|----------------------|---------------------------|--|
| | F/N (a) | Days to Failure (b) | Percent Loss in Tensile Strength | | F/N (a) | Days to Failure (b) | Percent Loss in Tensile Strength |
| <u>2219-T352 Aluminum Alloy Forging (10 in. Thick), Short Transverse^(c)</u> | | | | | | | |
| 75 | 3/3 | 1(3) | - | | 3/3 | 1, 1, 3 | - |
| 50 | 3/3 | 2, 2, 82 | | | 3/3 | 5, 24, 27 | - |
| 0 | 0/3 | Rem 84(3) | 27 ^(e) | | 0/3 | Rem 5, 24, 27 | 6, 28, 24 |
| <u>2219 T852 Aluminum Alloy Forging (10 in. Thick), Short Transverse^(c)</u> | | | | | | | |
| 75 | 0/3 | 183(3) NF | 16 ^(e) | | 1/3 | 33, 60(2) NF | 31, 32 |
| 0 | 0/3 | Rem 183(3) | 32 ^(e) | | 0/3 | Rem 33, 60(2) | 30, 34, (f) |
| <u>2219-T62 Aluminum Alloy Sheet (0.064 in. Thick), Transverse^(c)</u> | | | | | | | |
| Preform ^(d) | 0/3 | 183(3) NF | - | | No Specimens Exposed | | |
| 75 | 0/3 | 183(3) NF | 46 ^(e) | | 0/3 | 60(3) NF | 37 ^(e) |
| 0 | 0/3 | Rem 183(3) | 44 ^(e) | | 0/3 | Rem 60(3) | 38 ^(e) |
| <u>7079-T651 Aluminum Alloy Rolled Plate (6 in. Thick), Short Transverse^(c)</u> | | | | | | | |
| 25 | 0/3 | 183(3) NF | 42 ^(e) | | 3/3 | 4(3) | - |
| 15 | 0/3 | 183(3) NF | 13 ^(e) | | 0/3 | 61(3) NF | 14 ^(e) |
| 0 | 0/3 | Rem 183(3) | 12 ^(e) | | 0/3 | Rem 61(3) | 29 ^(e) |
| <u>7079-T651 Aluminum Alloy Rolled Plate (6 in. Thick), Long Transverse^(c)</u> | | | | | | | |
| 75 | 3/3 | 3, 6, 6 | - | | 3/3 | 6, 12, 15 | - |
| 0 | 0/3 | Rem 183(3) | 5 ^(e) | | 0/3 | Rem 6, 12, 15 | 2, 6, 3 |

* Tests performed by Alcoa (data reported by Alcoa).

(a) F-Number of specimens that failed

N-Number of specimens exposed.

(b) Rem - Unstressed specimens removed from test after exposure for number of days shown.

NF - Stressed specimens had not failed after exposure for number of days shown.

Numbers in parentheses refer to number of specimens.

(c) Principal axis of the specimen with respect to the direction of working.

(d) Preform - Specimen deformed to introduce residual stresses and then additionally stressed by constant strain method.

(e) Average value for number of specimens exposed.

(f) Specimen broke while removing it from test.

Table 3. Results obtained from stress-corrosion tests conducted in an artificial laboratory environment (1N NaCl solution with 10 ml 30% H₂O₂/l of solution - intermittent immersion).

| Exposure Stress, Percent of Yield Strength | Constant Strain Method | | | | Remarks | Constant Load Method | | |
|---|------------------------|---------------------------|--|--|----------------------|----------------------|---------------------------|--|
| | F/N (a) | Days to Failure (b) | Percent Loss in Tensile Strength | | | F/N (a) | Days to Failure (b) | Percent Loss in Tensile Strength |
| <u>2219-T352 Aluminum Alloy Hand Forging (10 in. Thick), Short Transverse^(c)</u> | | | | | | | | |
| 75 | 3/3 | 2, 2, 8 | - | | 3/3 | 1, 1, 2 | - | |
| 50 | 3/3 | 1, 1, 8 | - | | 3/3 | 2, 3, 3 | - | |
| 0 | 0/3 | Rem 2, 2, 8 | (f) | | 0/3 | Rem 2, 3, 3 | 28, 29, 28 | |
| <u>2219-T852 Aluminum Alloy Hand Forging (10 in. Thick), Short Transverse^(c)</u> | | | | | | | | |
| 75 | 0/3 | 60(3) NF | (f) | | 3/3 | 19, 24, 41 | - | |
| 0 | 0/3 | Rem 60(3) | (f) | | 0/3 | Rem 19, 24, 41 | 37, 39, 57 | |
| <u>2219-T62 Aluminum Alloy Sheet (0.064 in. Thick), Transverse^(c)</u> | | | | | | | | |
| Preform ^(d) | 0/3 | 65(3) NF | | | No Specimens Exposed | | | |
| 75 | 0/2 | 65(2) NF | 51(e) | | 1/3 | 48, 65(2) NF | 41, 46 | |
| 0 | 0/2 | Rem 65(3) | 46(e) | | 0/3 | Rem 48, 65(2) | 34, 44, 51 | |
| <u>7079-T651 Aluminum Alloy Rolled Plate (6 in. Thick), Short Transverse^(c)</u> | | | | | | | | |
| 25 | 2/3 | 8, 21, 60 NF | (f) | | 3/3 | 2, 7, 7 | - | |
| 15 | 0/3 | 60(3) NF | (f) | | 0/3 | 61(3) NF | 47(e) | |
| 0 | 0/3 | Rem 60(3) | (f) | | 0/3 | Rem 61(3) | 47(e) | |
| <u>7079-T651 Aluminum Alloy Rolled Plate (6 in. Thick), Long Transverse^(c)</u> | | | | | | | | |
| 75 | 3/3 | 2(3) | - | | 3/3 | 13, 18, 18 | - | |
| 0 | 0/3 | Rem 2(3) | 3(e) | | 0/3 | Rem 13, 18, 18 | 0, 2, 3 | |

(a) F-Number of specimens that failed.

N-Number of specimens exposed.

(b) Rem - Unstressed specimens removed from test after exposure for number of days shown.

NF - Stressed specimens had not failed after exposure for number of days shown.

Number in parentheses refer to number of specimens.

(c) Principal axis of the specimen with respect to the direction of working.

(d) Preform - Specimen deformed to introduce residual stresses and then additionally stressed by constant strain method.

(e) Average value for number of specimens exposed.

(f) Data not available.





