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Date: December 12, 2021
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Report Number: ESP036520P.1R0

**ICC AC257 CONDITION 3 CORROSION RESISTANCE TEST
OF AEROSMITH SURE-BOLT EXTREME SCREW FASTENERS**

I hereby certify that this plan, specification or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

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INTRODUCTION

This report presents the results of fastener corrosion resistance testing in MCA treated wood conducted on one corrosion inhibiting coating system (Sure-Bolt Extreme). Samples were selected by U.L. International on June 6, 2021. Element tested randomly selected samples from the group of fasteners supplied. The fasteners were identified as Aerosmith Sure-Bolt Extreme screw anchors. The anchors are coated with a gray Atlantis epoxy coating.

OBJECTIVE

The scope of our work was limited to conducting corrosion resistance testing on the fastener coating to ICC/ES AC257, Section 4.0 for Coated Ferrous Fasteners – Exposure Condition 3 (Chemically Treated Wood and Moisture) exposure on fasteners in MCA minimum of 0.15 pcf retention treated wood, and providing a report of the results. The exposures were started on September 9, 2021 and completed on November 29, 2021.

CONCLUSIONS

The alternative coating **met the acceptance criteria** of ICC/ES AC257 – Exposure Condition 3 (MCA 0.15 pcf chemically treated wood and moisture) for Test Procedure 1 and Test Procedure 2 with corrosion resistance statistically equivalent to or better than the hot dip galvanized benchmark control group of fasteners. The corrosion resistance evaluations are presented in the “Summary of Results” section of this report. It should be noted that the screws tested were the 3/8” diameter. The tested screws are gray, but different colors may also be available with the same coating formulation and different pigment and should therefore be considered equivalent.

SAMPLE IDENTIFICATION Aerosmith Sure-Bolt Extreme concrete screw anchors were received in one size: hex head screws with a 19 mm diameter head, 9.48mm diameter shank and 4 inch overall length.

Wood Identification, Treatment Verification Content

The wood treatment selected for the testing was MCA minimum 0.15 pcf that were purchased in nominal sizes of 4” x 6” x 8 ft Southern Yellow Pine members from Menards in St. Paul – Midway MN. Before exposure moisture content: test board J – 14.7% - 16.2%. The moisture content after testing was 38.0% to 43.0% for B117 and 12.5% to 16.3% for the G85 boards.

Treated Wood Member ACQ Retention Level

| Test Board Reference | | | | | ACQ-D Retention Levels | | |
|---------------------------------|--------|---------|---|--------------|------------------------|----------|-----------------|
| Element Identification and Size | | | Timber Products Inspection (TPI) Report | | | | |
| Test Board ID | Size | Species | Sample ID | TPI Sample # | Cu (pcf) | Teb(pcf) | Total MCA (pcf) |
| J | 4”x 6” | SYP | J | 836447 | 0.196 | 0.008 | 0.203 |

The wood treatments of the Test Boards were verified by Timber Products Inspection in accordance with standards set forth by the American Wood Preservers’ Association manual.

Timber Products Inspection report



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Date: September 15, 2021

LABORATORY RESULTS

Client & Address: Element Materials Technology
Attn: Mr. Jim Clark
662 Cromwell Avenue, St. Paul, MN 55114

Test: Determination of MCA Concentration in Ten (10) Wood Samples

| TP Sample No. | Sample ID | Cu (pcf) | Teb (pcf) | Total MCA (pcf) |
|---------------|-----------|----------|-----------|-----------------|
| 836438 | A | 0.120 | 0.0004 | 0.120 |
| 836439 | B | 0.259 | 0.0010 | 0.260 |
| 836440 | C | 0.353 | 0.0009 | 0.354 |
| 836441 | D | 0.322 | 0.0010 | 0.323 |
| 836442 | E | 0.155 | 0.0004 | 0.155 |
| 836443 | F | 0.183 | 0.0004 | 0.184 |
| 836444 | G | 0.325 | 0.0007 | 0.326 |
| 836445 | H | 0.148 | 0.0005 | 0.148 |
| 836446 | I | 0.183 | 0.0005 | 0.184 |
| 836447 | J | 0.196 | 0.0080 | 0.203 |

pcf = Pounds per Cubic Foot

The pcf was calculated using a density of 32.0 for Southern Yellow Pine per standard A12-19 of the AWPA Book of Standards.

The wood samples were received and analyzed via analytical procedures from the American Wood Protection Association (AWPA) Book of Standards.

Note: These samples were submitted by the client. These results should not be construed as acceptance or rejection of any lot or lots which may be in question. Timber Products Inspection, Inc. waives all responsibility for any damages resulting from the usage and/or implementation of the products or data described in the report.

Report Authorized By:



Greg Pittman
Manager, TP Analytical Laboratory

Verification of Hot Dip Galvanized Benchmark Zinc Coating Weights

The benchmark test specimens were provided to Element uncoated. Hot dipped galvanizing was applied by Emerald Galvanizing located in Seattle, Washington. The zinc coating weights were determined by Element St Paul in accordance with ASTM A90-13. The specimens did not have an unthreaded shank, so full 6 full sizes fasteners were stripped and weighed. The surface area of the screws is known to be approximately 7.56 square inches. The hot dipped galvanized screws had an average coating weight of 1.06 oz/sq ft.

TEST METHODS

The coating test was set-up and conducted as outlined in ICC/ES AC257 “Acceptance Criteria for Corrosion-Resistant Fasteners and Evaluation of Corrosion Effects of Wood Treatment Chemicals” with the test samples exposed to: Exposure Condition 3 (Chemically treated wood and moisture) environment per Test Procedure 1, ASTM B117 and Test Procedure 2, ASTM G85 Annex A5 Cyclic Fog/Dry.

General Set-up and Installation

Ten (10) fasteners were randomly selected from the group submitted and cleaned per ASTM G1 ultrasonically in deionized water at room temperature with a 7.5 minute submersion time. Test boards were cut from the boards noted above and assigned to the Procedure 1 and Procedure 2 exposures as noted. The screws with the coating system along with a set of the benchmark Hot Dip Galvanized were installed in groups into the 4” face and across the test boards spaced at least 12 fastener diameters apart, in a staggered pattern along center lines following the spacing requirements in AC257 section 4.1.5. With the fasteners to be no closer than 2 inches from either end with 1 ½ inches of space between them along the length of the board keeping them at least ½ in. from the edge of the boards. The fasteners were inserted without pre-drilled pilot holes into treated wood members using drive-heads of the recommended size. After all fasteners were inserted, kerf-cuts were made between them across the boards that were as deep as the fasteners penetrated the test boards as pictured below.

TEST SETUP

Procedure 1 (ASTM B117 exposure) Condition 3 (moisture) Test Board Set-up



Procedure 2 (ASTM G85 A5 exposure) Condition 3 (moisture) Test Board Set-up



TEST PROCEDURE

The boards were then placed in their respective chambers and exposed to the conditions of the two following test procedures.

Test Procedure 1 - ASTM B117 “Standard Practice for Operating Salt Spray (Fog) Apparatus”

The ACQ-D test boards were positioned with the fastener head facing horizontal in Singleton Salt Spray Chamber PT-165-010 for the duration of 1440 hours with rust evaluations on the exposed heads at 336-hour intervals, under the following conditions:

| | |
|-------------------------|---------------------------|
| Test Media: | ASTM D1193, Type IV water |
| Cabinet Temperature: | 93 to 97°F |
| Fog Collection Rate: | 1.4 to 1.8 ml/hr |
| Specific Gravity: | 1.032 to 1.036 |
| Humidifier Temperature: | 97 to 100°F |
| Tower Pressure: | 12 psi |

Test Procedure 2 - ASTM G85 “Standard Practice for Modified Salt Spray (Fog) Testing” Annex A5 “Dilute Electrolyte Cyclic Fog/Dry Test”.

The ACQ-D test boards were positioned with the fastener head facing horizontal in Q-Fog Cyclic Salt Spray Chamber PT-165-011 and exposed to 720 cycles of 1hr fog and 1hr dry-off for a total duration of 1440 hours with rust evaluations on the exposed heads at 336 hour intervals, under the following conditions:

| | |
|--------------------------|-------------------------------------|
| Test Media: | ASTM D1193, Type IV water |
| Fog Collection Rate: | 1.2 to 1.6 ml/hr over a 24hr period |
| Cabinet Temperature Fog: | 75 to 80°F |
| Fog Temperature: | 92 to 98°F |
| Fog Delivery Pressure: | 8.5 psi |
| Cabinet Temperature Dry: | 92 to 98°F |

Following the 1440 hour exposure in Test Procedure 1, ASTM B117 and Test Procedure 2 and ASTM G85 Annex A5 Cyclic Fog/Dry, both Condition 3, the wood with test samples were removed from the chambers and the moisture content was obtained. The final photographs and rust evaluation of the heads were then conducted and the wood members split apart to remove the test screws. As needed the screws with stuck-on wood fibers were cleaned per ASTM G1 ultrasonically in deionized water at room temperature with a 7.5 minute submersion time and lightly brushed to remove them. The shanks of the test screws for each coating system were then photographed and evaluated for corrosion and base metal exposure to the acceptance criteria of ICC/ES AC257.

REMARKS

Element Materials Technology is A2LA Accredited for ASTM B117 Salt Spray and ASTM G85, Annex A5 Cyclic Salt Spray testing under Certificate Number 1479.01.

Calibrated Equipment:

Q-Fog Cyclic chamber, PT-165-011

Singleton chamber, PT-165-010

Extech digital thermometer, PT-162-042

SUMMARY OF RESULTS

Corrosion evaluation of the test fastener heads along with the shanks following exposure to Exposure Condition 3- Test Procedure #1 and Test Procedure #2.

Based on the data shown below, the t score was 0 for both the head and threads for Procedure 1, and was 0 for the head and -1.19 for the threads. Therefore since both sections of the screws were less than or equal to 1.72 for both procedure 1 and 2, it is shown that the alternative fasteners are equal to or better than the benchmark fasteners in all cases.

| Coating Number | Corrosion Data Collected Using AC257 Test Protocol-Results of Condition #3 Test Procedure #1 | | | | | | | | |
|----------------|--|------|------|--------------------|--------------------------|-------|--------------------|--------------------------|--|
| | Fastener Designation - <i>Aerosmith Sure-Bolt Extreme</i> | | | | | | | | |
| | % Surface Area Red Rust @ 1440 Hours | | | | | | | | |
| | One Tail T-Test | | Head | | | Shank | | | |
| | Pass | Fail | Mean | Standard Deviation | Coefficient of Variation | Mean | Standard Deviation | Coefficient of Variation | |
| Benchmark | - | - | 0.0 | 0.0 | #DIV/0! | 2.0 | 2.6 | 129.1 | |
| Alternate | X | - | 0.0 | 0.0 | #DIV/0! | 2.0 | 2.6 | 129.1 | |

Exposure Condition 3, Test Procedure 1, ASTM B117 Test Fastener Evaluation

| Coating Number | Corrosion Data Collected Using AC257 Test Protocol-Results of Condition #3 Test Procedure #2 | | | | | | | | |
|----------------|--|------|------|--------------------|--------------------------|-------|--------------------|--------------------------|--|
| | Fastener Designation - <i>Aerosmith Sure-Bolt Extreme</i> | | | | | | | | |
| | % Surface Area Red Rust @ 1440 Hours | | | | | | | | |
| | One Tail T-Test | | Head | | | Shank | | | |
| | Pass | Fail | Mean | Standard Deviation | Coefficient of Variation | Mean | Standard Deviation | Coefficient of Variation | |
| Benchmark | - | - | 0.0 | 0.0 | #DIV/0! | 4.0 | 6.1 | 153.7 | |
| Alternate | X | - | 0.0 | 0.0 | #DIV/0! | 1.5 | 2.4 | 161.0 | |

Exposure Condition 3, Test Procedure 2, ASTM G85 Test Fastener Evaluation

Calculations:

The pass/fail criteria for the test specimens were based on a one sided student's t-test, to determine if the benchmark and alternate fasteners were statistically equivalent levels of corrosion protection, or if the alternative fasteners were more resistant to corrosion than the benchmark fasteners.

The student's t-test was used assuming 20 samples per data set (the sum of the benchmark and alternate fasteners) with confidence of 90%. This gives a required t value of ≤ 1.72 . The associated formulas for calculating the t value of the data sets are:

$$t = \frac{x-u}{\frac{s}{\sqrt{n}}}$$

$$s = \sqrt{\left(\frac{\sigma_{alt}^2}{10}\right) + \left(\frac{\sigma_{bench}^2}{10}\right)}$$

Where:

t = the t score

x = sample (alternate) mean

u = population (benchmark) mean

s = pooled standard deviation

σ = standard deviation (of the alternate or benchmark fastener data sets)

TEST RESULTS

Progressive Head Ratings:

| Fastener | Coating System | # | % Corrosion Product on the Exposed Fastener Head by Visual Evaluation Every 336 Hours for Condition #3 Test Procedure #1 in | | | | | | | |
|-------------------|----------------|----|---|---------|-----------|---------|------------|---------|------------|---------|
| | | | 336 Hours | | 672 Hours | | 1008 Hours | | 1440 Hours | |
| | | | % Red | % White | % Red | % White | % Red | % White | % Red | % White |
| Sure-Bolt Extreme | Benchmark HDG | 1 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| | | 2 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| | | 3 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| | | 4 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| | | 5 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| | | 6 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| | | 7 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| | | 8 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| | | 9 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| | | 10 | 0 | 100 | 0 | 100 | 0 | 100 | 0 | 100 |
| | Alternative | 1 | 0 | 2 | 0 | 5 | 0 | 10 | 0 | 20 |
| | | 2 | 0 | 2 | 0 | 5 | 0 | 10 | 0 | 20 |
| | | 3 | 0 | 2 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 4 | 0 | 2 | 0 | 10 | 0 | 10 | 0 | 10 |
| | | 5 | 0 | 2 | 0 | 5 | 0 | 10 | 0 | 10 |
| | | 6 | 0 | 2 | 0 | 5 | 0 | 10 | 0 | 20 |
| | | 7 | 0 | 2 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 8 | 0 | 2 | 0 | 10 | 0 | 10 | 0 | 10 |
| 9 | 0 | 2 | 0 | 5 | 0 | 10 | 0 | 20 | | |
| 10 | 0 | 2 | 0 | 10 | 0 | 10 | 0 | 10 | | |

| Fastener | Coating System | # | % Corrosion Product on the Exposed Fastener Head by Visual Evaluation Every 336 Hours for Condition #3 Test Procedure #2 in | | | | | | | |
|-------------------|----------------|----|---|---------|-----------|---------|------------|---------|------------|---------|
| | | | 336 Hours | | 672 Hours | | 1008 Hours | | 1440 Hours | |
| | | | % Red | % White | % Red | % White | % Red | % White | % Red | % White |
| Sure-Bolt Extreme | Benchmark HDG | 1 | 0 | 0 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 2 | 0 | 0 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 3 | 0 | 0 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 4 | 0 | 0 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 5 | 0 | 2 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 6 | 0 | 2 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 7 | 0 | 5 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 8 | 0 | 5 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 9 | 0 | 10 | 0 | 10 | 0 | 10 | 0 | 20 |
| | | 10 | 0 | 10 | 0 | 10 | 0 | 10 | 0 | 20 |
| | Alternative | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

Final Shank and Thread Evaluations:

| Fastener | Coating System | Test Sample # | % Corrosion Product on the Fastener Shank and Diameter by Visual Examination after 1440 Hours of | | | |
|-------------------|----------------|---------------|--|---------|----------|---------|
| | | | ASTM B117 | | ASTM G85 | |
| | | | % Red | % White | % Red | % White |
| Sure-Bolt Extreme | Benchmark HDG | 1 | 0 | 40 | 5 | 0 |
| | | 2 | 0 | 40 | 0 | 0 |
| | | 3 | 0 | 40 | 0 | 0 |
| | | 4 | 0 | 40 | 0 | 0 |
| | | 5 | 0 | 20 | 0 | 0 |
| | | 6 | 5 | 20 | 20 | 0 |
| | | 7 | 5 | 20 | 0 | 0 |
| | | 8 | 0 | 30 | 5 | 0 |
| | | 9 | 5 | 30 | 5 | 0 |
| | | 10 | 5 | 30 | 5 | 0 |
| | Alternative | 1 | 5 | 20 | 0 | 0 |
| | | 2 | 5 | 20 | 0 | 0 |
| | | 3 | 0 | 20 | 5 | 0 |
| | | 4 | 0 | 20 | 0 | 0 |
| | | 5 | 0 | 20 | 5 | 0 |
| | | 6 | 0 | 40 | 5 | 0 |
| | | 7 | 5 | 30 | 0 | 0 |
| | | 8 | 5 | 20 | 0 | 0 |
| | | 9 | 0 | 20 | 0 | 0 |
| | | 10 | 0 | 20 | 0 | 0 |

Note: the photographs on Pages 13 and 16 show some wood stuck to the surface of the threaded portion of the screws. In some cases this look a little bit red, however these areas are generally not rust, rather it is just the color of the wood.

TEST PHOTOGRAPHS – PROCEDURE 1

Test Procedure 1, ASTM B117 Test Fasteners Evaluations

Photographs Benchmark and Alternate following 1440 hours of B117 exposure





Benchmark Fasteners



Alternate Fasteners



Fasteners, Procedure 1 (B117), Progressive Head Corrosion 336 hours



Fasteners, Procedure 1 (B117), Progressive Head Corrosion 672 hours



Fasteners, Procedure 1 (B117), Progressive Head Corrosion 1008 hours



Fasteners, Procedure 1 (B117), Progressive Head Corrosion 1440 hours

TEST PHOTOGRAPHS – PROCEDURE 2

Test Procedure 2, ASTM G85 Test Fasteners Evaluations

Photographs Benchmark and Alternate following 1440 hours of G-85 exposure





Benchmark Fasteners



Alternate Fasteners



Fasteners, Procedure 2 (G-85), Progressive Head Corrosion 336 hours



Fasteners, Procedure 2 (G-85), Progressive Head Corrosion 672 hours



Fasteners, Procedure 2 (G-85), Progressive Head Corrosion 1008 hours



Fasteners, Procedure 2 (G-85), Progressive Head Corrosion 1440 hours



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August 7, 2023

Aerosmith Fastening Systems

Memorandum: Discussion of Results for the Aerosmith Sure-Bolt Extreme Screw Anchors

Element has performed tests under ESR 4314 on the Sure-Bolt Extreme Anchors. The tests were conducted under Element Project Number ESP036520P. The results of the testing are intended to show the corrosion performance of these screws (with a proprietary coating), in comparison to standard hot dipped galvanized screws. The conditions screws were tested in was Exposure Condition 3 (moisture with no salt) of AC 257, which was performed in MCA chemically treated wood with a minimum treatment level of 0.15 pcf.

The results of the test were than under the conditions tested, the Sure-Bolt Extreme were statistically equal to or better than the standard ASTM A153 Class D hot dipped galvanized screws. These screws are approved for use in this condition.

Sincerely,

A handwritten signature in blue ink, appearing to read 'Luke Tavernit'.

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