

Corrosion of Roofing Fastener Systems

Draft Final Report

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Background

- 2013 – 2014: Survey of 385 roofing contractors
 - Electrogalvanized fastener corrosion is common
 - Corrosion in coastal applications is prevalent
 - Corrosion in inland applications is not uncommon
 - Outcomes justified a follow up experimental studies
- 2014 – 2015: Experimental evaluation of fastener corrosion
 - Electrogalvanized fasteners tested in multiple configurations
 - Applied TAS 114 Appendix E test protocol
 - Gradations of corrosion documented

Testing: 2014 - 2015

- Test out-of-the-box fasteners side-by-side with fasteners installed / removed in various substrates
- The test protocol followed TAS I 14 Appendix E
 - Failure if $> 5\%$ surface area indicates failure
- An integer scale of 1 – 8 was created to classify the degree of corrosion observed on the fasteners



1: no corrosion observed

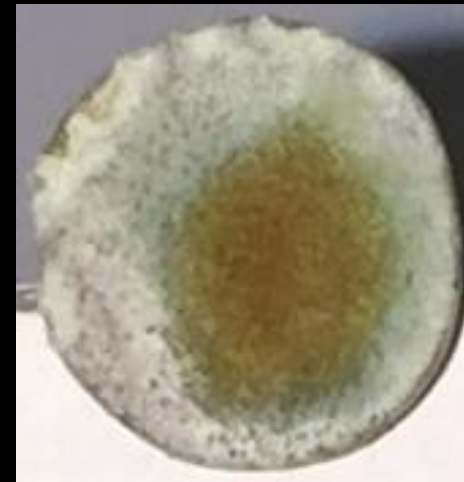


2: Edge corrosion only



3: Light partial surface corrosion

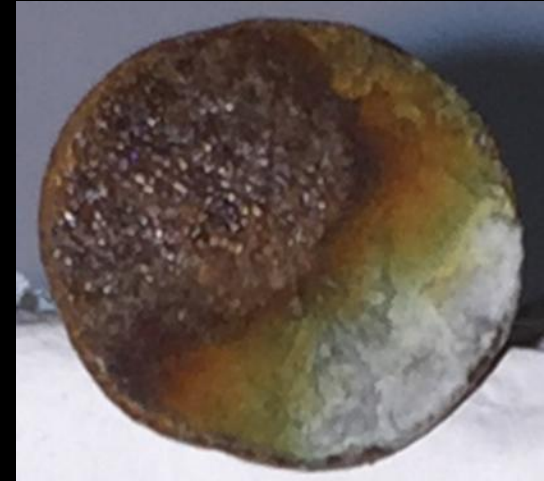
most scores of 3 would fail TAS criterion of
> 5% surface corrosion



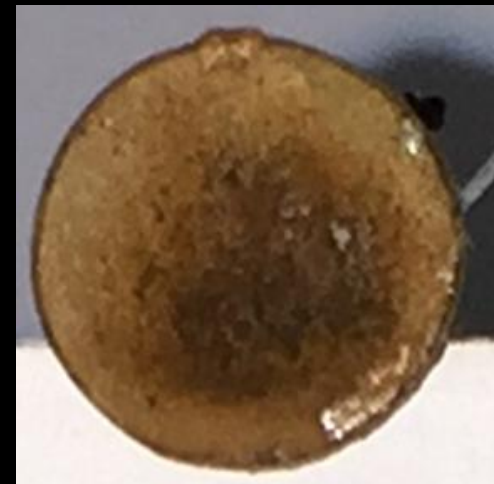
4: Light full surface corrosion



5: Partial heavy surface corrosion



6: Partial heavy and partial light full surface corrosion



7: Heavy full surface corrosion without scaling



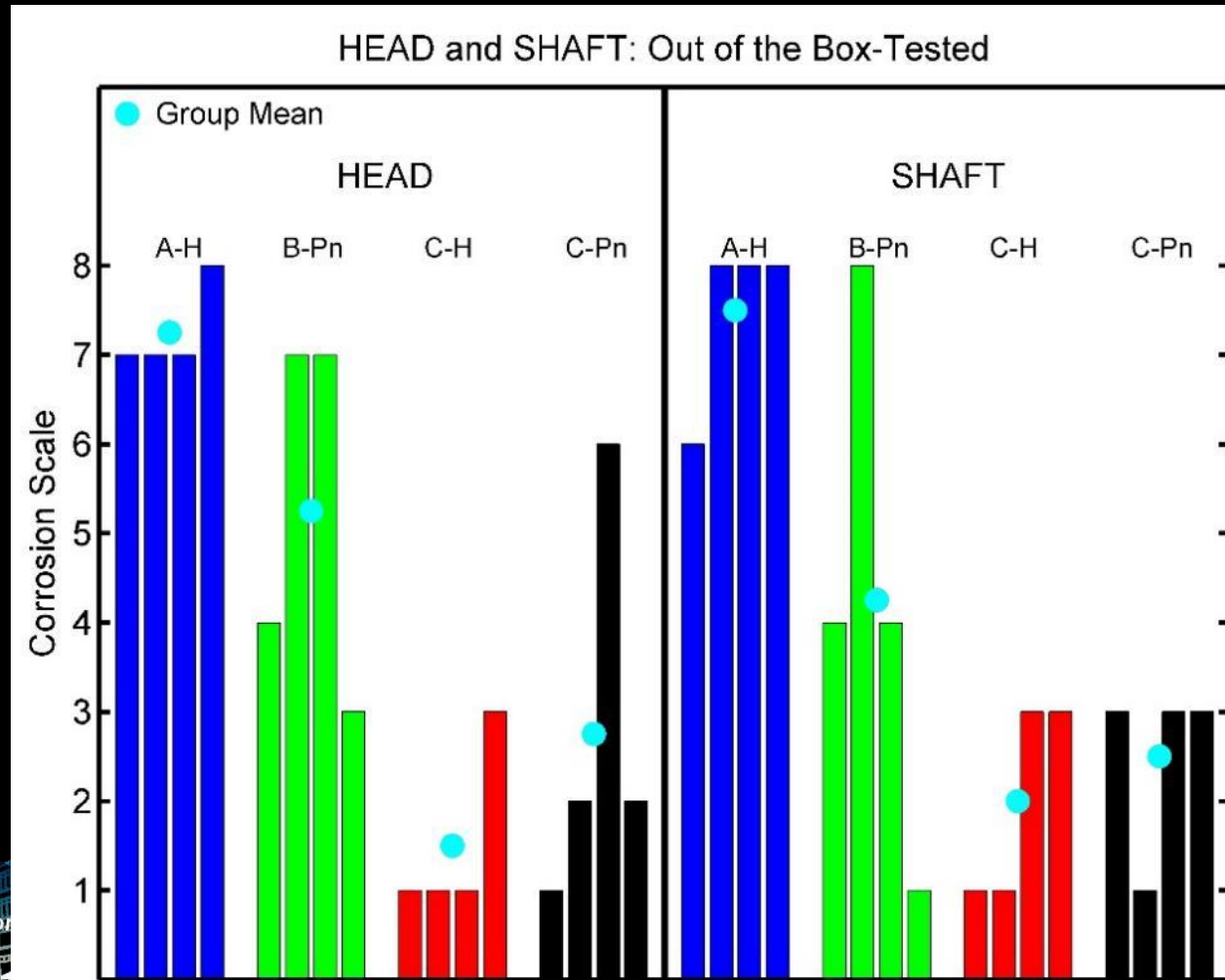
8: Heavy full surface corrosion with scaling



Results: 2014 - 2015

Corrosion scale results for 16 roof fasteners tested out of the box (configuration OB)

- Manufacturers C & D clearly shows better performance
- This set corresponds to the TAS 114 test specimen conditions



Results: 2014 - 2015

- A wide disparity in the performance of electrogalvanized fasteners from different manufacturers was observed
- A high failure rate of the TAS 114 criterion for electrogalvanized fasteners was observed
- The tested fasteners were electrogalvanized, but not marked at ASTM A641 or TAS 114 compliant
- The results provide a baseline against which to measure ASTM A641 and TAS 114 compliant fasteners
- Are they any better than unlabeled EG fasteners?

2015 – 2016 Work

Goals:

- Test-1: Determine whether ASTM A641 and TAS 114 Appendix E certified fastener performance exceeds the baseline electrogalvanized results from the 2014 – 2015 study
- Test-2: Investigate the influence of installation on hot dipped nails
- Test-3: Investigate the corrosion performance of screen enclosure fasteners (concrete, SMS and SDS: stainless, ceramic coated)

Approach: Apply TAS 114 Appendix E testing (Section 2.6.1) to evaluate the degree of corrosion resistance of fasteners

2015 – 2016 Work: Test-1

- Specimen types

- 1 ¼” EG nails, HVHZ and non-HVHZ CHINA
- 1 ¼” hot dipped coil nails CHINA
 - Note: hot dipped coating ~ 10 times thicker zinc coating than EG
- 3” stainless steel patio/deck nails TAIWAN
- 2 ½” Electroplated (EP) tile screws USA
- 2 ½” Mechanically galvanized tile screws USA
 - Note mechanically galvanized thicker zinc coating than electroplated
- Hot dipped screws CHINA

- Suppliers include north, central and south Florida

- 10 of each type were tested



Table 1: 16 specimen types tested to date (10 samples of each)

Group number	Product type	Coating type	Certification	Supplier location
1	1 ¼ nail	EG	ASTM F1667	Orlando
2	1 ¼ nail	EG	Unknown	Orlando
3	1 ¼ coil nail	EG	Unknown	Orlando
4	1 ¼ coil nail	EG	ASTM F1667	Gainesville
5	1 ¼ coil nail	EG	ASTM A153 Class D	Orlando
6	#8 2 ½ tile screw	MG	ASTM B695 Class 55 2006 IRC Compliant	Orlando
7	#8 2 ½ tile screw	EP	unknown	Bradenton
8	1 ¼ coil nail	EG	ASTM F1667	Bradenton
9	1 ¼ coil nail	HD	Unknown	Sarasota
10	1 ½ screws	HD	No info	No info
11	10d 3" RS	SS	MDC Approved HVHZ	Miami
12	1 ¼ RS nail	HD	MDC Approved ASTM F1667 HVHZ	Miami
13	1 ¼ nail	EG	MDC Approved ASTM F1667 HVHZ	Miami
14	1 ¼ coil RS nail	EG	MDC Approved ASTM A641	Miami
15	1 ¼ coil RS nail	EG	Non HVHZ, MDC approved ASTM A641	West Palm
16	#8 2 ½ tile screw	MG	ASTM B695 Class 55 2006 IRC Compliant	West Palm

Notes:

ASTM F1667 → ASTM A641 compliant

ASTM A153 Class D thicker zinc coating than ASTM A641

ASTM B695 → mechanical galvanizing standard, Class 55 → 0.0022" zinc thickness

HVHZ → Miami Dade County compliant

EG → electrogalvanized, EP → electroplated, MG → mechanically galvanized, HD → hot dipped,

SS → stainless steel

2015 – 2016 Work: Test-2

- Specimen types

- 1 1/4" EG nails, unmarked

CHINA

- 1 1/4" hot dipped smooth shank nails

CHINA

- 1 1/4" hot dipped ring shank nails

CHINA

- Note: hot dipped coating ~ 10 times thicker zinc coating than EG

- Each of the above three types were tested out of the box and installed-removed

- 10 of each type were tested = 60 samples

2015 – 2016 Work : Test-2

Table 2: test-2: 3 specimen types, 10 samples of each out-of-the-box, 10 samples of each installed and removed prior to testing
Status: completed 280 hours (140 cycles)

Group number	Product type	Coating type	Certification	Testing Configuration
1	1 ¼ coil nail	EG	Not marked	Out of box
2	1 ¼ coil nail	EG	Not marked	Installed and removed
3*	1 ¼ coil nail	HD	Not marked	Out of box
4*	1 ¼ coil nail	HD	Not marked	Installed and removed
5**	1 ¼ RS nail	HD	ASTM F1667	Out of box
6**	1 ¼ RS nail	HD	ASTM F1667	Installed and removed

Notes:

ASTM F1667 → ASTM A641 compliant

* same specimen type as Group 9 in test-1

** same specimen type as Group 12 in test-1

2015 – 2016 Work: Test-3

- Specimen types
 - 304 stainless masonry screws: ceramic coated
 - 4 sizes
 - 316 stainless SDS: ceramic coated
 - 5 sizes
 - 316 stainless SMS: ceramic coated
 - 2 sizes
 - Unmarked masonry screws: bought off the shelf
 - 2 sizes
 - Unmarked SDS: bought off the shelf
 - Unmarked SMS: bought off the shelf
- 10 of each type were tested out of the box
- 1000 hour test (500 cycles of one hour on, one hour drying)

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2015 – 2016 Work : Test-3

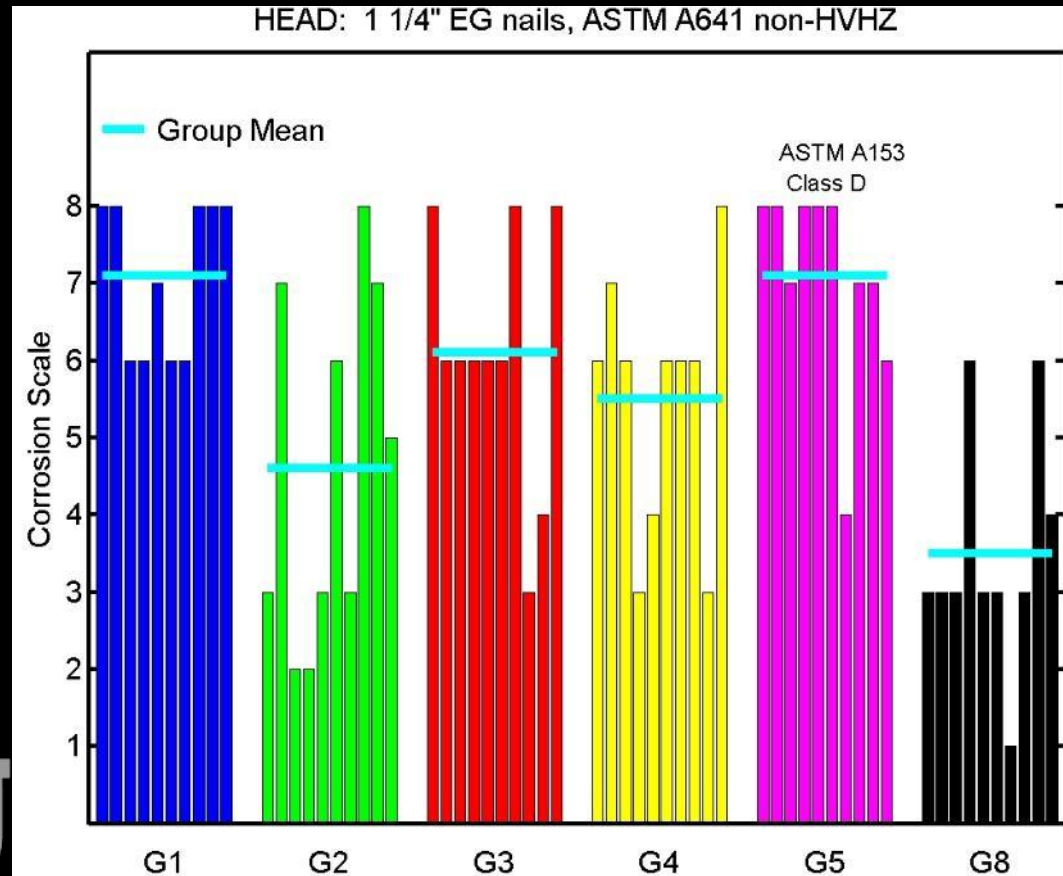
**Table 3: test-3: 11 specimen types, 10 samples of each, and 5 specimen types, 8 samples of each
Status: 765 hours of 1000 hours completed (382 out of 500 cycles completed)**

Group number	Product type	Use	Certification	Coating
1	Hex 3/8 x 5 304 Stainless white	Masonry	MDC Approved	Ceramic
2	Hex 3/8 x 7 304 Stainless white	Masonry	MDC Approved	Ceramic
3	Hex 1/4 x 3 ¼ 304 Stainless silver	Masonry	MDC Approved	Ceramic
4	Hex 1/4 x 2 ¼ 304 Stainless silver	Masonry	MDC Approved	Ceramic
5	Hex 1/4 10 x 2 SMS 316 Stainless bronze	Screen enclosure	TBD	Ceramic
6	Hex 1/4 12 x ¾ SDS 316 Stainless bronze	Screen enclosure	TBD	Ceramic
7	Hex 5/16 14 x 1 SDS 316 Stainless bronze	Screen enclosure	TBD	Ceramic
8	Hex 3/8 14 x 1 SDS 316 Stainless bronze	Screen enclosure	TBD	Ceramic
9	Hex 5/16 12 x 2 SDS 316 Stainless bronze	Screen enclosure	TBD	Ceramic
10	Hex 1/4 12 x 3/4 SDS Stainless white	Screen enclosure	TBD	Ceramic
11	Hex 1/4 10 x 2 SMS Stainless white	Screen enclosure	TBD	Ceramic

2015 – 2016 Work: Test-I

Figure I: All 1 1/4" electrogalvanized (EG) nails compliant with ASTM A641, **non-HVHZ**. Head results shown, shaft very similar

Generally, no improvement from 2014-2015 EG samples

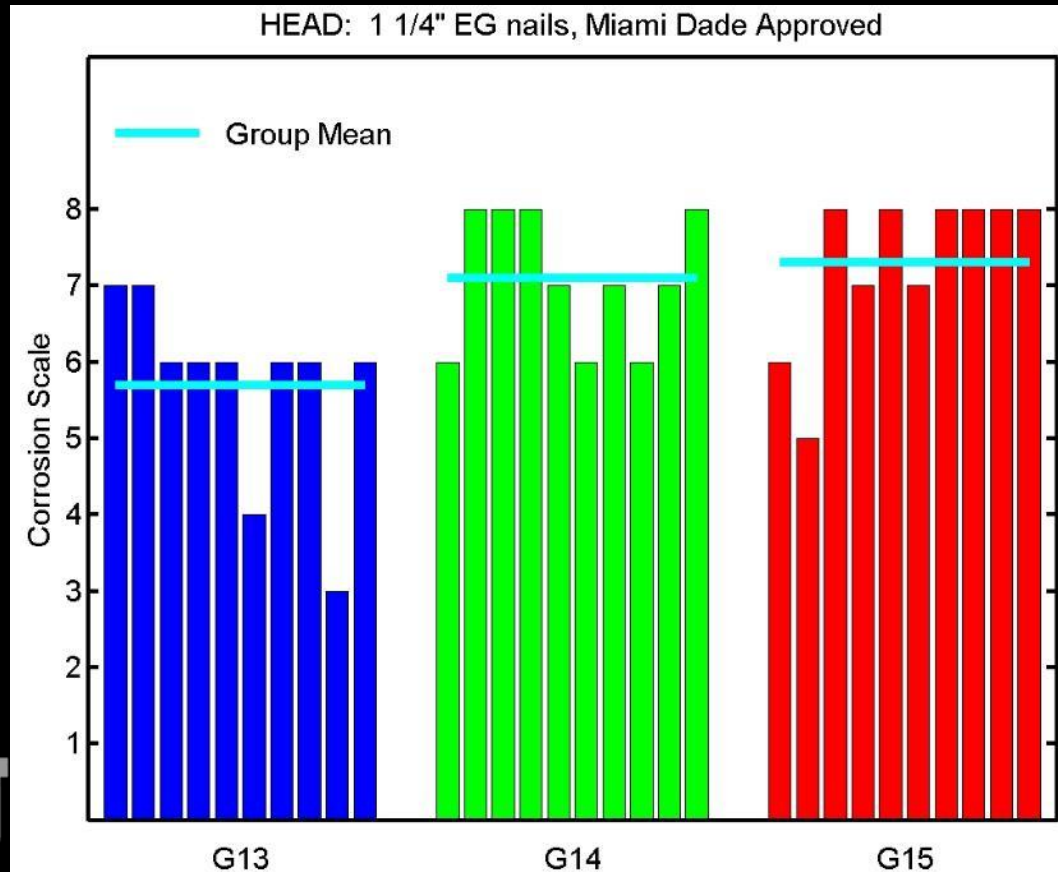


Next graph: EG HVHZ

2015 – 2016 Work: Test-I

Figure 2: All 1 1/4" EG nails compliant with ASTM A641, HVHZ approved. Head results shown, shaft very similar

HVHZ approved EG no better than Non-HVHZ EG



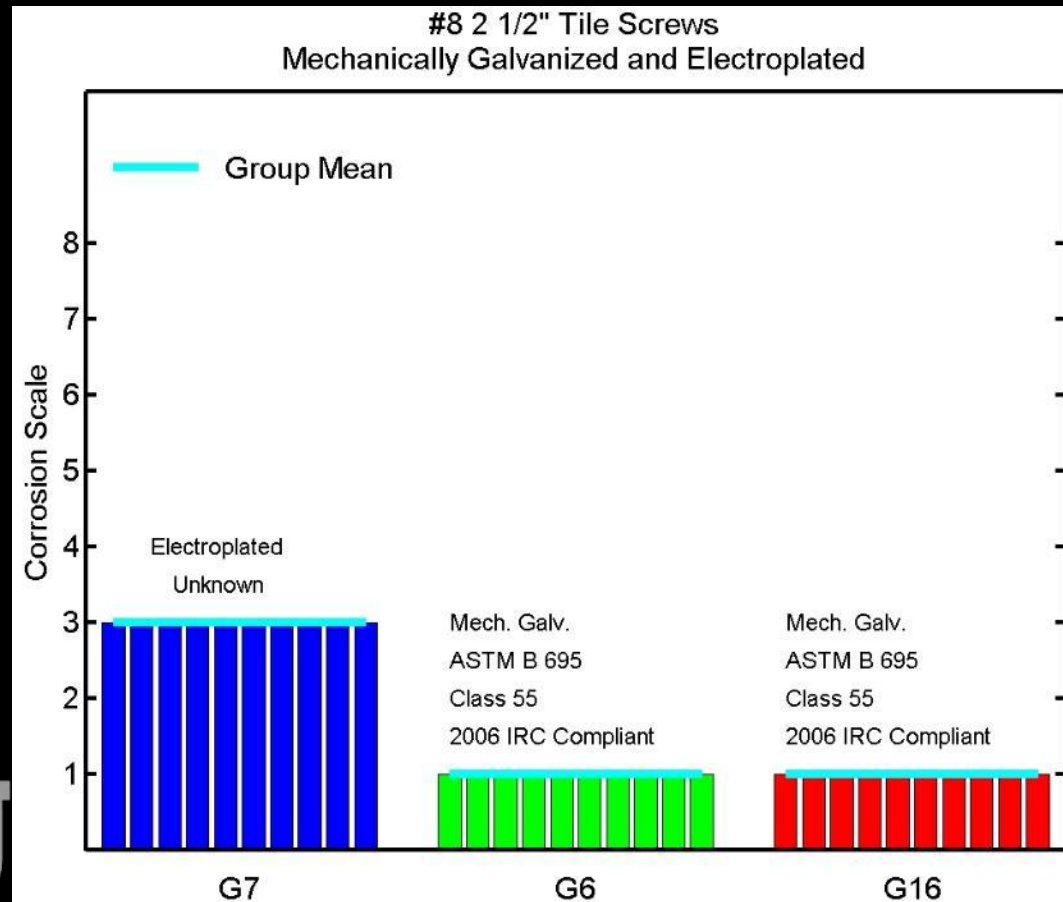
Next graph: MG and EP tile screws

2015 – 2016 Work: Test-I

Figure 3: #8 2 1/2" roof tile screws, two mechanically galvanized specimens and one electroplated specimen. Head and shaft identical.

No visible corrosion on any sample of MG tile screws

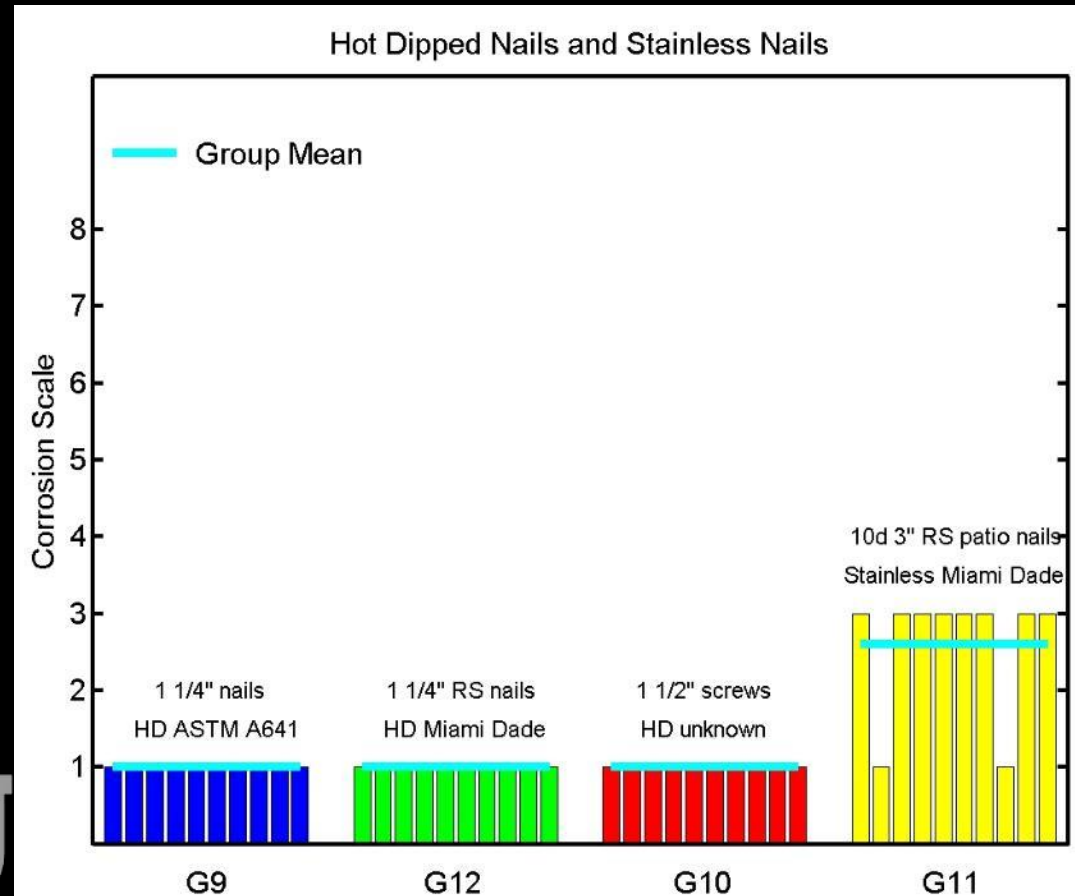
Next graph: Hot dipped and SS



2015 – 2016 Work: Test-I

Figure 4: Two hot dipped 1 1/4" nail specimens, one hot dipped 1 1/2" screw enclosure fastener specimen, and one 10d 3" stainless steel patio/deck nail specimen. Head results shown. Shaft results identical.

No visible corrosion on any sample of hot dipped fasteners



North Florida EG coil nail ASTM F1667 → ASTM A641



Central Florida EG coil nail ASTM F1667 → ASTM A641



South Florida EG coil nail ASTM A641 HVHZ – Approved



Hot dipped nails



2015 – 2016 Work: Test- I

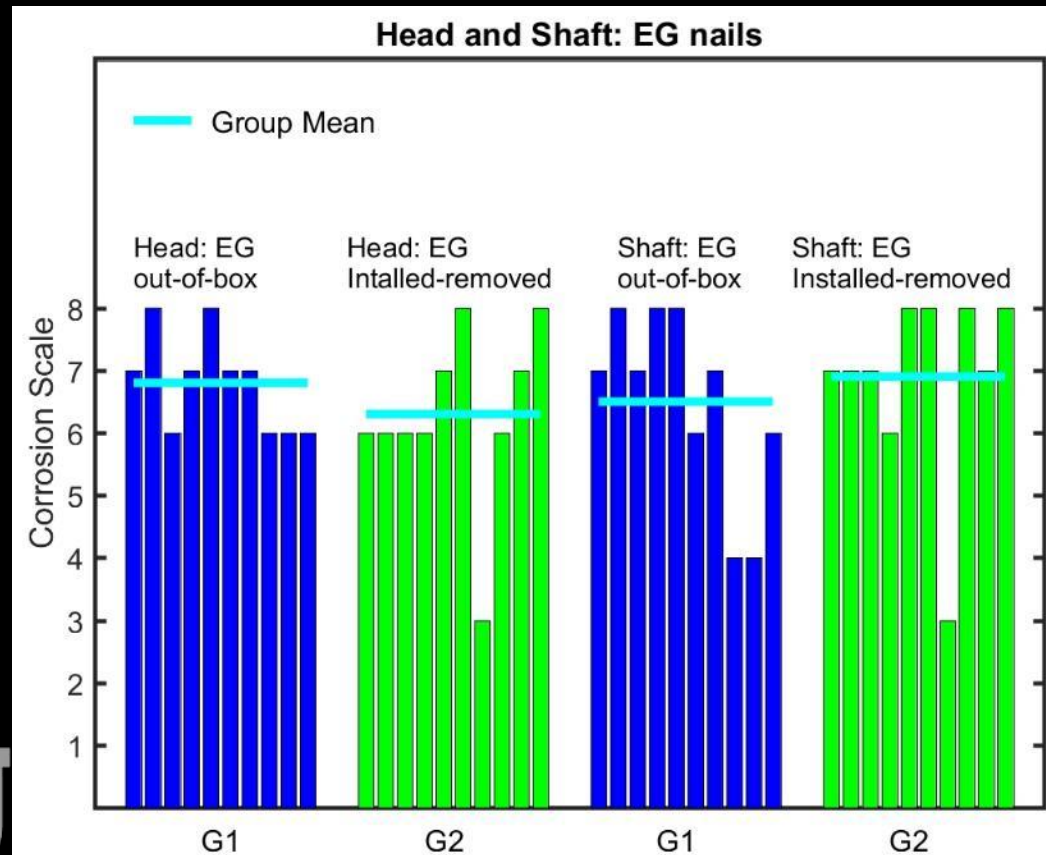
• Observations

- ASTM A641 certified EG performance no better than unlabeled EG fasteners from the previous year's study
- TAS 114 E compliant EG fasteners perform no better than ASTM A641
- Hot dipped fasteners perform much better than EG fasteners
- Mechanically galvanized (MG) screws perform better than EP screws
- Miami-Dade approved EG fasteners: The results did not reveal a single EG sample that passed the TAS 114E criterion of $< 5\%$ surface corrosion. Each of the fastener samples tested had a score of at least 3 (partial light surface corrosion), and most samples displayed significant heavy corrosion
- Only the hot dipped and mechanically galvanized specimens demonstrated no corrosion in any of the samples

2015 – 2016 Work: Test-2

Figure 5: 1 1/4" EG nails, no certification marking. Blue: tested out-of-the-box. Green: installed-removed prior to testing.

Poor performance
Install has no influence

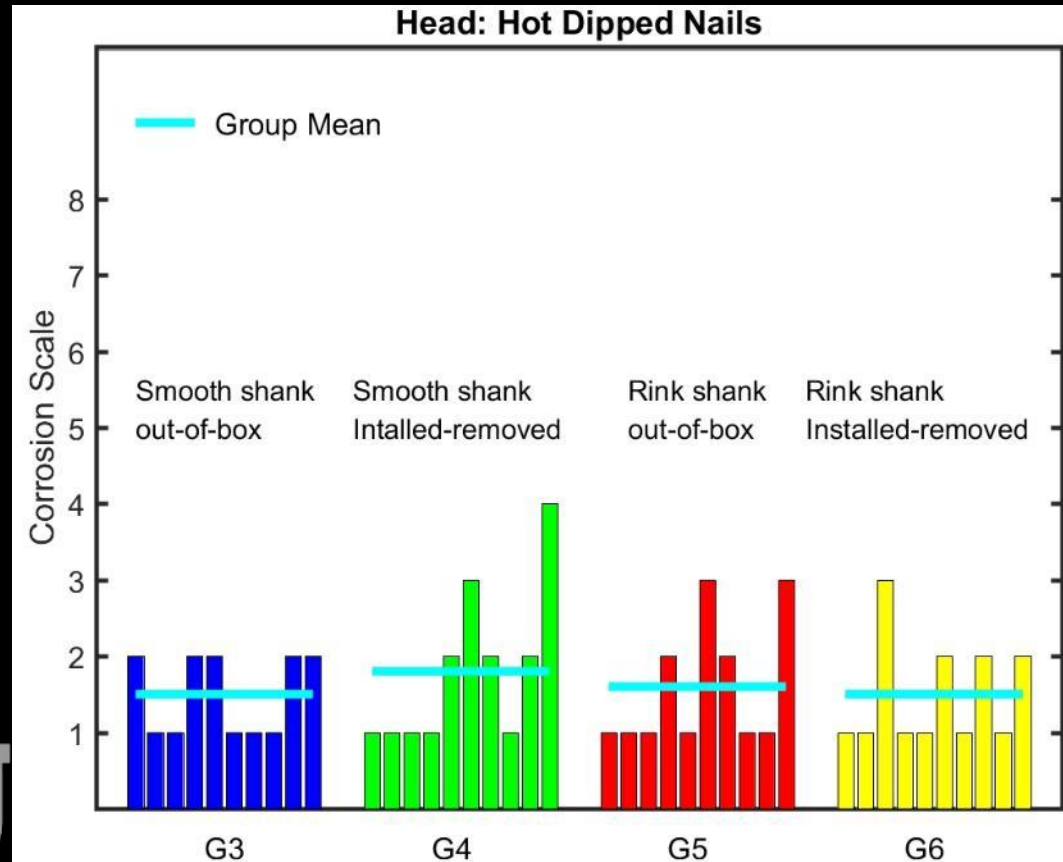


Next graph: hot dipped head

2015 – 2016 Work: Test-2

Figure 6: Test-2 1 1/4" Hot dipped nails, tested out-of-the-box and installed-removed as noted: Head results

Good performance
Install has no obvious influence

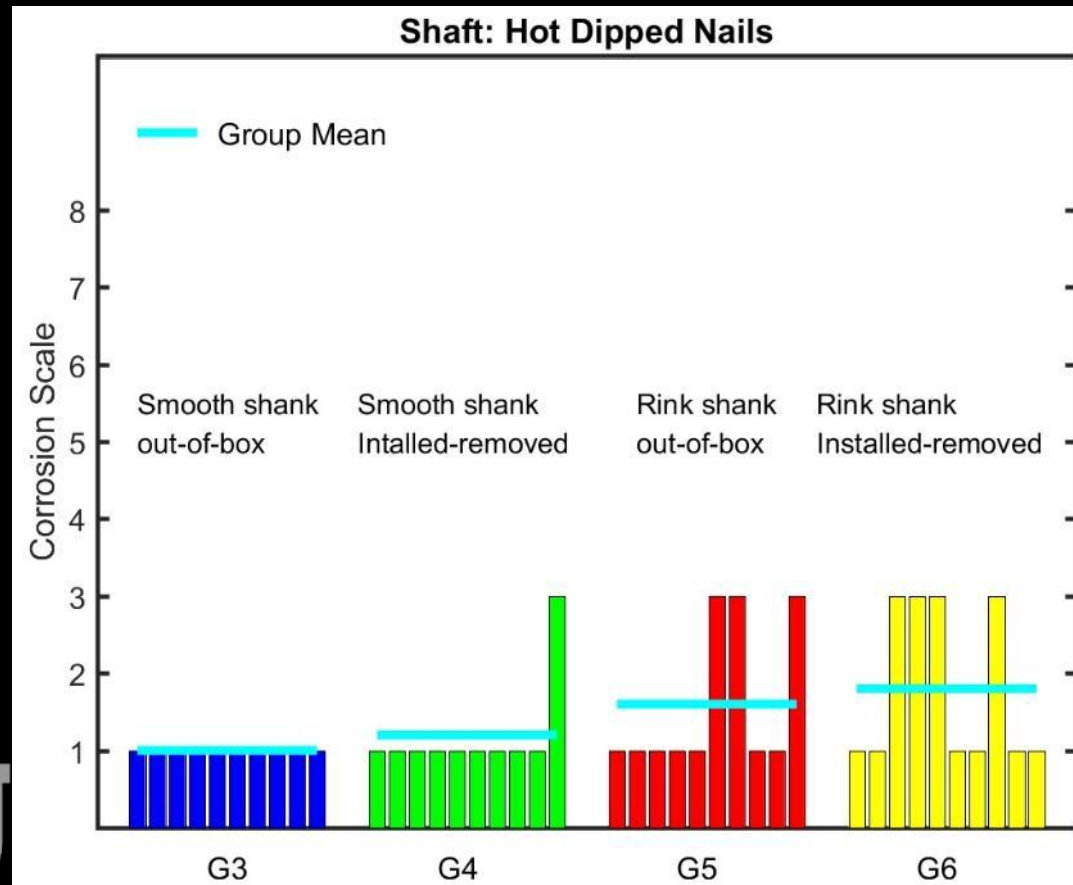


Next graph: hot dipped shaft

2015 – 2016 Work: Test-2

Figure 6: Test-2 1 1/4" Hot dipped nails, tested out-of-the-box and installed-removed as noted: Shaft results

Good performance
Install has no obvious influence



Test-2 hot dipped out of the box



Test-2 hot dipped installed-removed



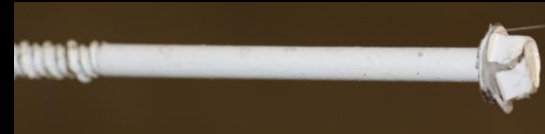
Test-2 hot dipped installed-removed



2015 – 2016 Work: Test-3

- Testing completed last week (1000 hours)
- Scoring not yet completed
- Photos are provided to show typical performance

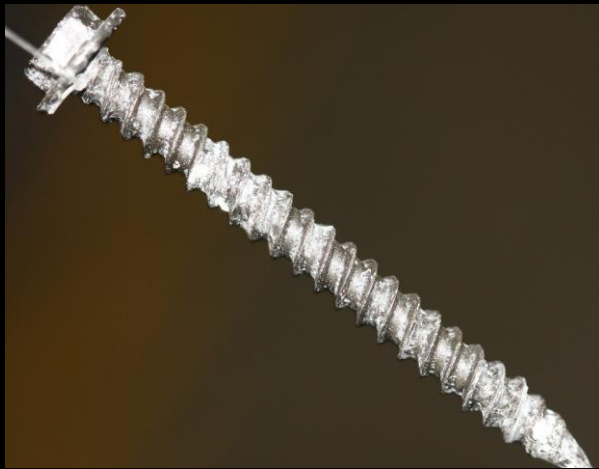
Test-3: 304 stainless: ceramic coated



Test-3: 304 stainless: ceramic coated



Test-3: 316 stainless: ceramic coated



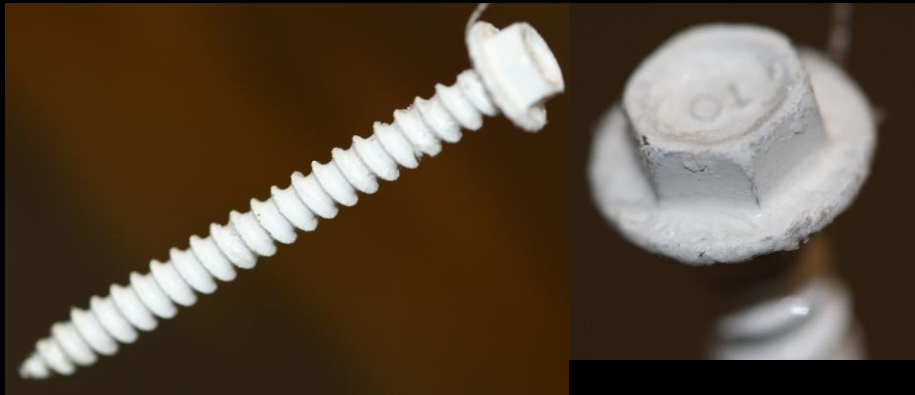
Test-3: 316 stainless: ceramic coated



Test-3: 316 stainless: ceramic coated



Test-3: 316 stainless: ceramic coated



Test-3: unmarked

