Protecting Bridge Steel Using A Duplex Coating System

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Duplex Coating System

- A duplex system is formed by painting or powder coating over hot-dip galvanized steel.
- Used since 1940's in Europe *

Duplex Systems, J.F.H. van Eijnsbergen, 1994

Project Team

-KYTC

Division of Structural Design

Division of Construction

Division of Materials

-University of Kentucky KTC

- FHWA

Objectives

-Rapid Construction

-Long Service Life

-Low Maintenance

Long Service – Low Maintenance

-Galvanized Structural Steel

-Duplex Coating System

-Galvanized Rebar

-Concrete Stain

-Deck Sealing

Project Field Details

-Rural

-Low ADT (1300)

-Low Clearance

-Two Bridges

Bridge 1- Ky 6 over Stewart Creek

Bridge 2 - Ky 6 over Lynn Camp Creek

Bridge 1

4 Beams

48.5 Feet

Bridge 2

6 Beams

59 Feet

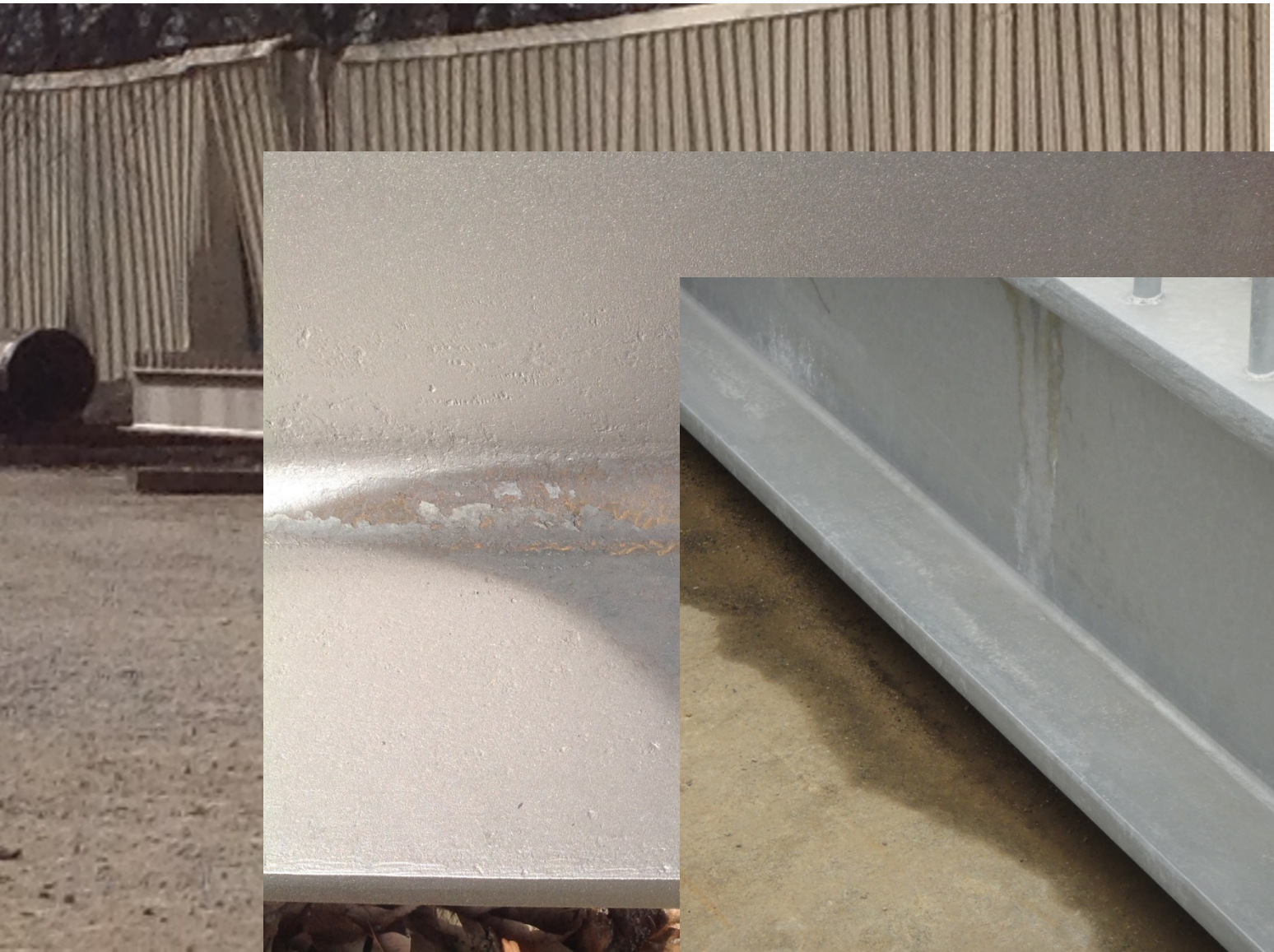
Galv. Rebar

Fabricated Beams

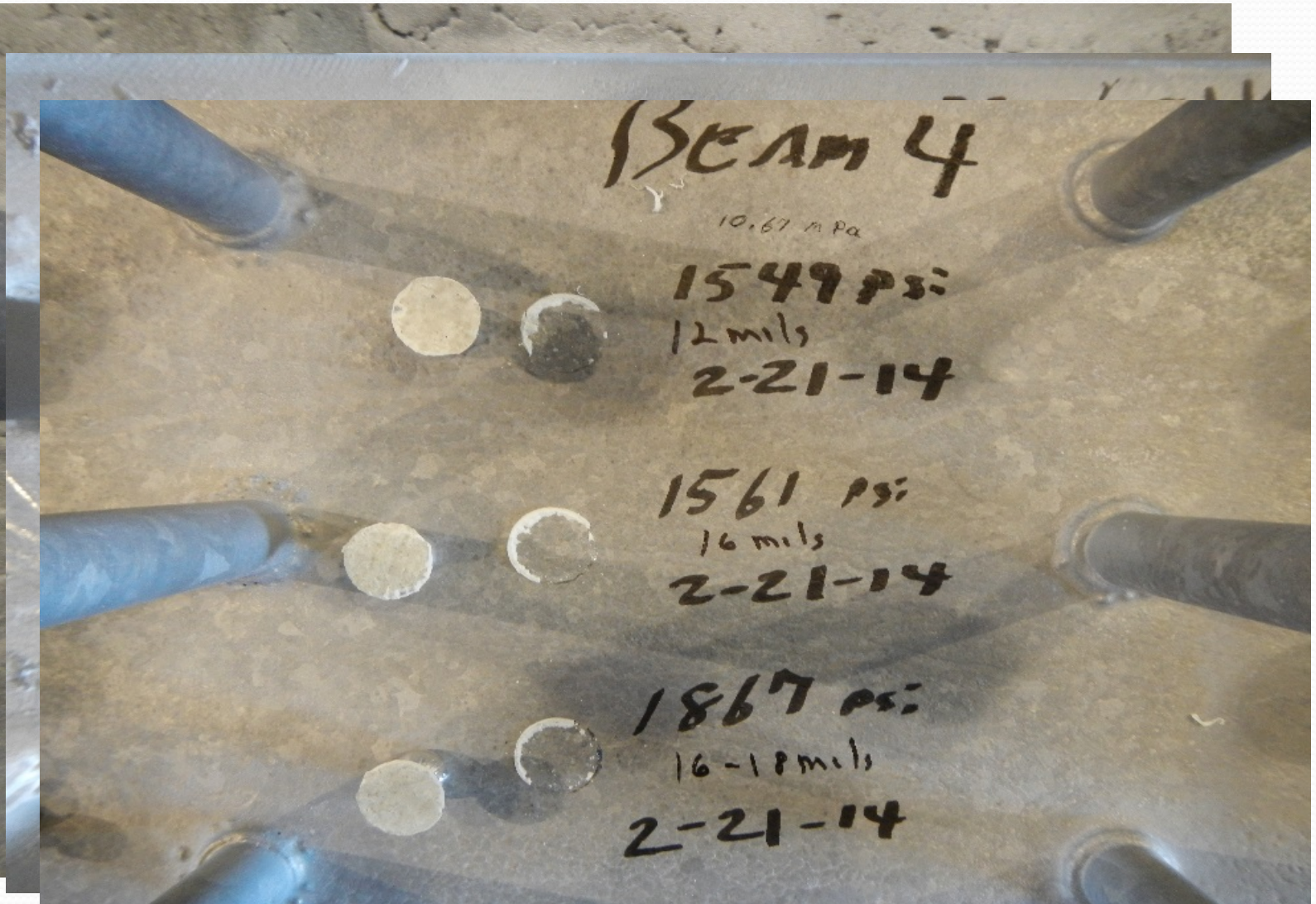
HDG Specifications

- ASTM A 6 (Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling).
- AASHTO M111 (Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products).
- AASHTO M232 (Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware).
- ASTM A143 (Standard Specification for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement).
- ASTM A385 (Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
- ASTM A780 (Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings)
- ASTM D6386 (Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting)

Surface Preparation



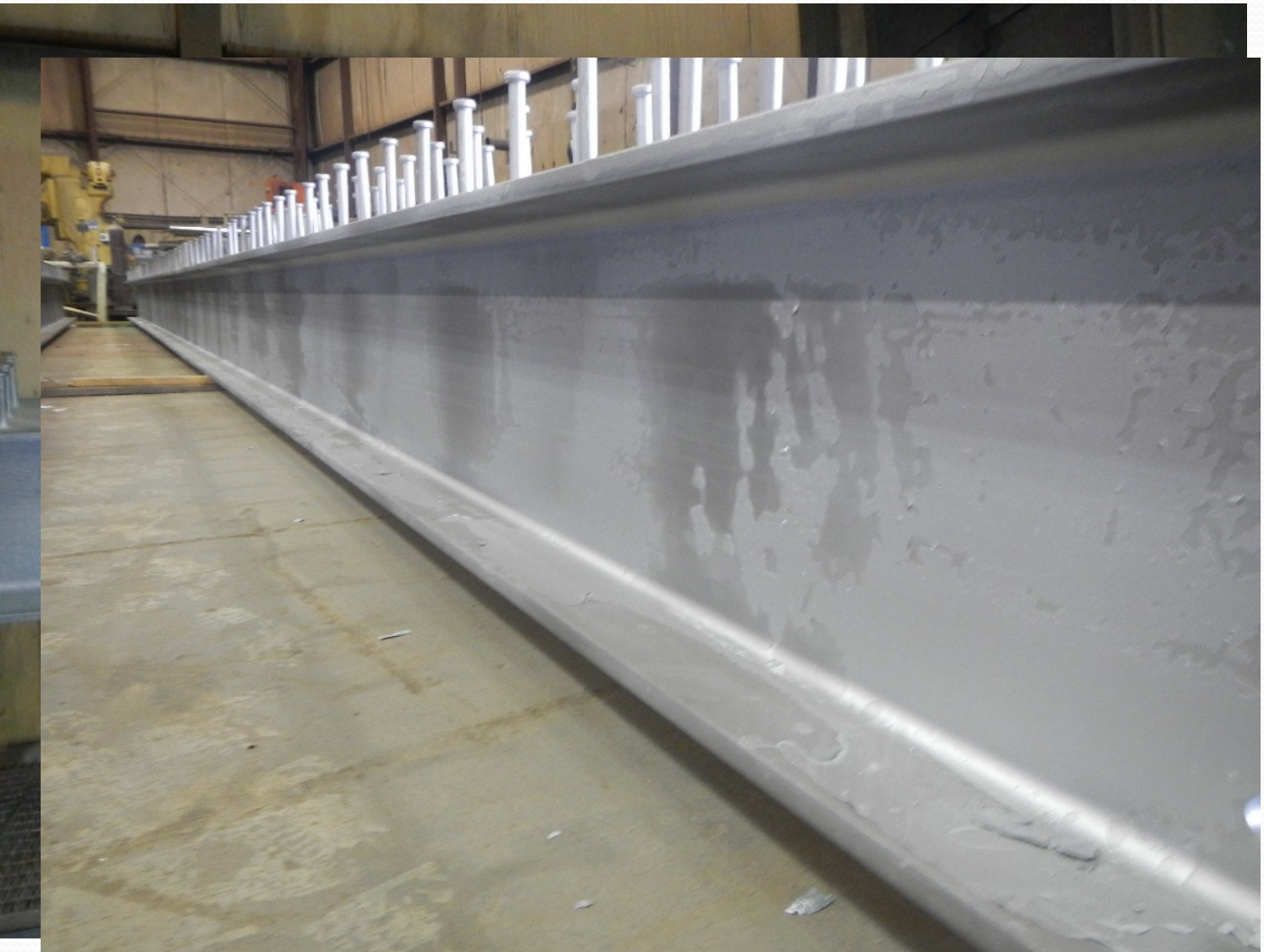
First HDG


Beam 4
10.67 mPa
1549 psi
12 mils
2-21-14
1561 psi
16 mils
2-21-14
1867 psi
16-18 mils
2-21-14

First HDG Flaws

Ultrasonic Testing For Delamination

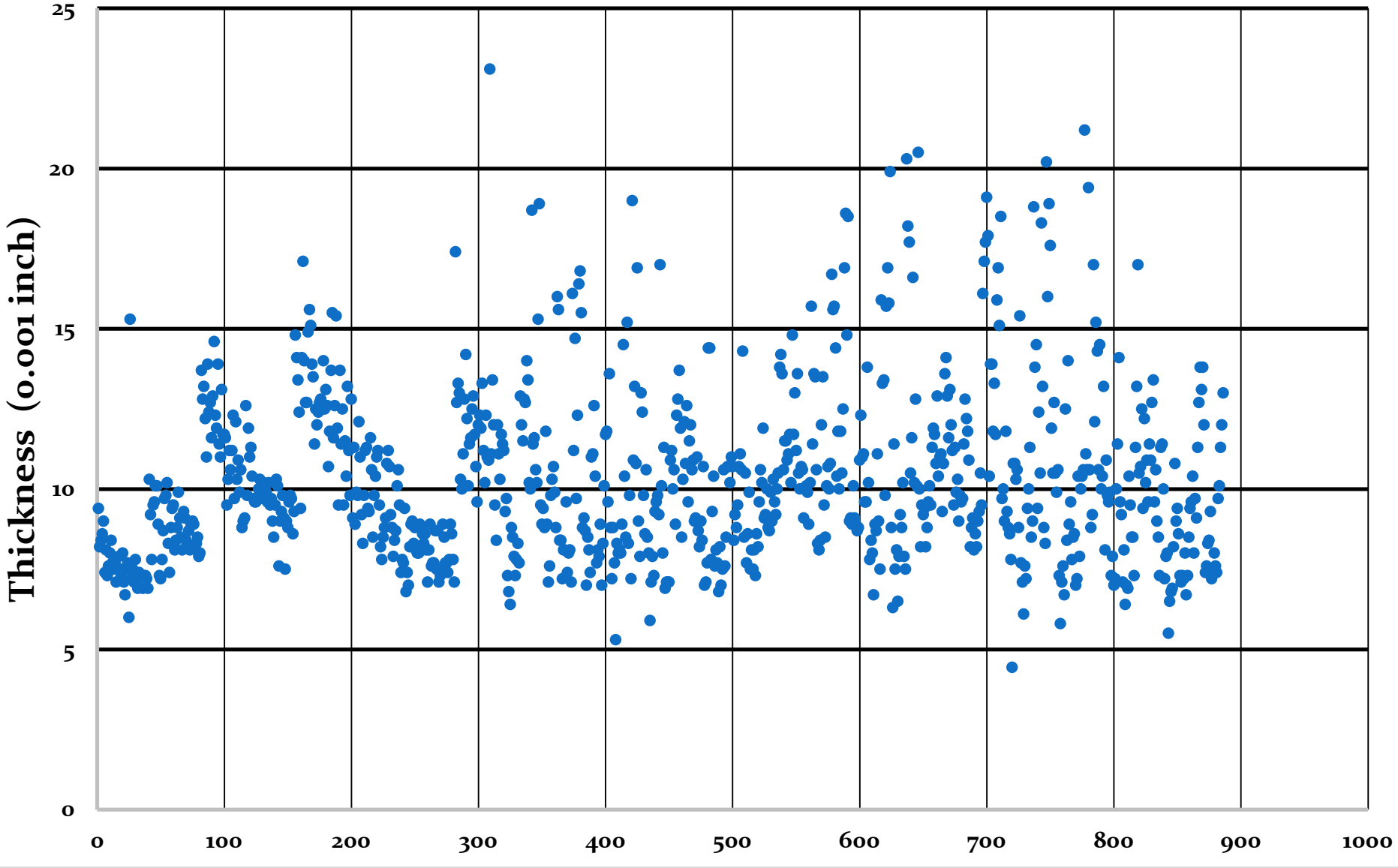
Surface Preparation For Redipping



At The HDG Facility

HDG Touch-up and Repair

HDG Thickness



Surface Preparation And Coating

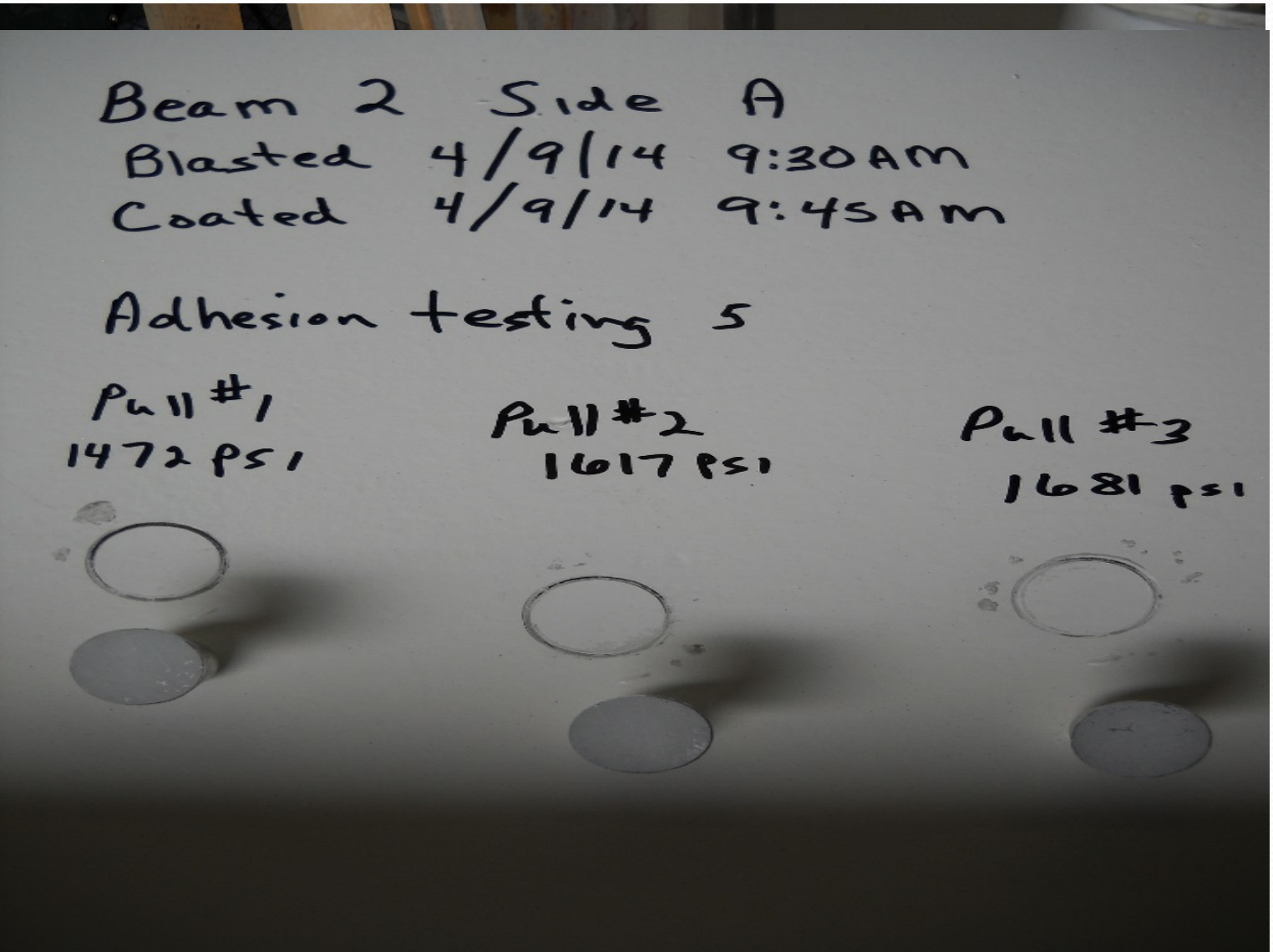
- The blast cleaned surface will have a surface profile of 0.5 to 1.0 mil, not to exceed 1.0 mil, as measured by ASTM D4417 (Standard Test Method for Surface Profile of Blast Cleaned Steel) Method B.
- Galvanized surfaces to be painted will be cleaned per ASTM D6386 with the exception that Aqueous Alkaline Cleaning (5.3.1) will not be permitted.
- Apply the intermediate and finish coats of a paint system on the KYTC List of Approved Materials

Painting HDG

Painting Details

Duplex Systems

Test Panels


Beam 2 Side A
Blasted 4/9/14 9:30AM
Coated 4/9/14 9:45AM
Adhesion testing 5
Pull #1
1472 psi
Pull #2
1617 psi
Pull #3
1681 psi

Paint Adhesion At Various Timing After HDG Surface Preparation

Coating Adhesion over HDG - Applied 4/8 - 9/2014

Test Beam #	Side	Date Tested	Coated After Blasting (hr)	Pull 1 (psi)	Pull 2 (psi)	Pull 3 (psi)	Average (psi)
2	A	5/9/2014	0.25	1442	1617	1681	1580
2	B	5/9/2014	7	2127	2270*	1837	1982
3	A	5/9/2014	22	2012	1982	1956	1983
4	A	5/9/2014	31	1591	2255*	2246*	1591
2	A	9/23/2015	0.25	1904	2211	2288	2134
2	B	9/14/2015	7	1723	1699	1909	1777
3	A	9/14/2015	22	1414	1286	1702	1467
4	A	9/14/2015	31	1520	1449	1205	1391

Conclusions

- Specify that steel to be HDG will have consistent surface preparation (i.e. SSPC SP 6)
- Specify steel chemistry (i.e. limit silica, phosphorus, manganese)
- Angle of removal from HDG bath is very important
- Be alert for HDG cracking especially at lift/handling areas
- Thicker HDG is adherent but difficult to duplex
- HDG repair should not produce sparks
- HDG touchup primer should be compatible with duplex mid-coat
- Standards and Guide need to be reviewed and revised for structural steel applications

Thank You

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