



Transportation Research Division



Technical Report 13-01

*Experimental Use of Line-X® Coated Steel Pipe Piles,
Clay Hill Bridge (#2157) Replacement Project over the
Mousam River, Route 9/Western Avenue, Kennebunk, Maine*

February 2013

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Transportation Research Division

Experimental Use of Line-X® Coated Steel Pipe Piles,
Clay Hill Bridge (no. 2157) Replacement Project over the
Mousam River, Route 9/Western Avenue in Kennebunk, Maine

Project Description

Steel pipe piles used by MaineDOT for bridge construction are typically coated with a fusion-bonded epoxy (FBE). FBE is a powder-based coating with properties similar to traditional epoxies. Its name is derived from the process by which it adheres to a substrate. When the hardener and epoxy react through heating, the coating takes a solid form as the chemicals are cross-linked and bonded to the substrate (ThomasNet.com).

One of the major problems with the FBE coating is that once cured it is brittle and tends to chip easily from handling during shipping, stockpiling, and the driving process. Recoating and repair of the FBE finish in the field can take up to two hours to complete.

Line-X® coating is a tough, yet resilient polyurea-based coating system that has demonstrated its resistance to chipping and de-bonding in its history as a spray-on lining for pickup truck beds. Line-X® Franchise Development Company of Huntsville, AL is a manufacturer and franchisor of their patented spray applied protective coatings systems used primarily for truck bed lining. Line-X® coating is a two-step process using their FCP primer and XS-350 top coat which is a 100% polyurea elastomer coating.

FCP Primer is a high-solids, two-component urethane primer for steel prepared to near-white blast cleaning and applied according to the manufacturer's specifications. The recommended dry film thickness is between 2-3 mils. FCP Primer has a volatile organic compound (VOC) content of 250 grams per liter.

XS-350 is a two-component, 100% high performance aromatic polyurea spray elastomer system with a zero VOC content. XS-350 is applied using heated (120°-150°F) high-pressure, plural component spray equipment. The dry film thickness for this project is specified a minimum of 125 mils for the XS-350 and as specified by the manufacturer for the FCP primer.

Twelve spiral welded steel pipe piles, 24 inches in diameter with a .0625 (5/8) inch wall thickness, were constructed in conformance with ASTM A252, Grade 3. The following is a schedule of piles at the pier locations from the project documents:

Pier No. 1	Piles 1 & 6:	2 ~ 2'-0" Ø x 5/8" thick x 55' long
	Piles 2 through 5:	4 ~ 2'-0" Ø x 5/8" thick x 52' long
Pier No. 2	Piles 1 & 6:	2 ~ 2'-0" Ø x 5/8" thick x 59' long
	Piles 2 through 5:	4 ~ 2'-0" Ø x 5/8" thick x 57' long

After fabrication, the piles were shipped to Dinsmore Welding & Fabricating of Dagus Mines, Pennsylvania for surface prep and coating. According to the project plans, only the top twenty-seven feet of each pile was coated with the Line-X® material (Figure 4). Details of the surface preparation and coating process are outlined in the project’s Special Provision (Appendix A).

Objective

The objective of this study is to determine if the Line-X® product is a longer lasting and more durable coating for steel pipe piles than the traditional fusion-bonded epoxy coating that we are now using.

The product will be evaluated by the Transportation Research Division over a five-year period for durability, aesthetics, and cost-effectiveness.

Project Location

The bridge selected for the demonstration project is the Clay Hill Bridge (Bridge No. 2157) that carries State Route 9 (locally: Western Ave.) over the Mousam River in Kennebunk, York County, Maine. The project scope is total replacement of the existing structure.

The project location is shown on the map below.

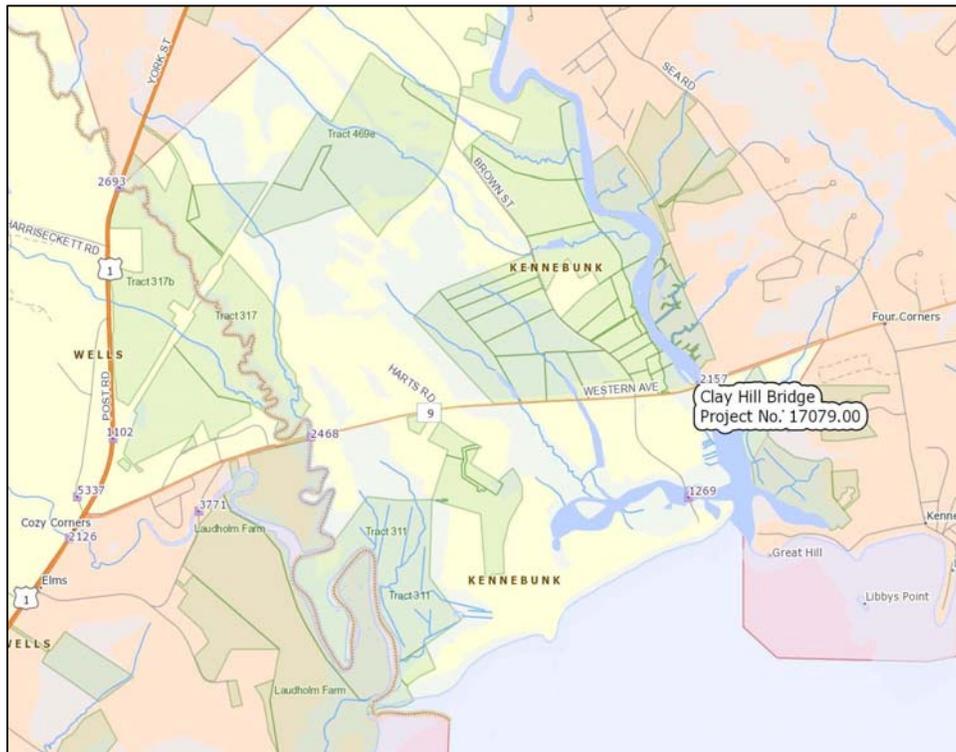


Figure 1
Project Location Map

Plans and Typical Sections

Filename: ...msta004_General_Plan_B.dgn Division: BRIDGE Username: Alan.Halhou Date: 4/3/2012

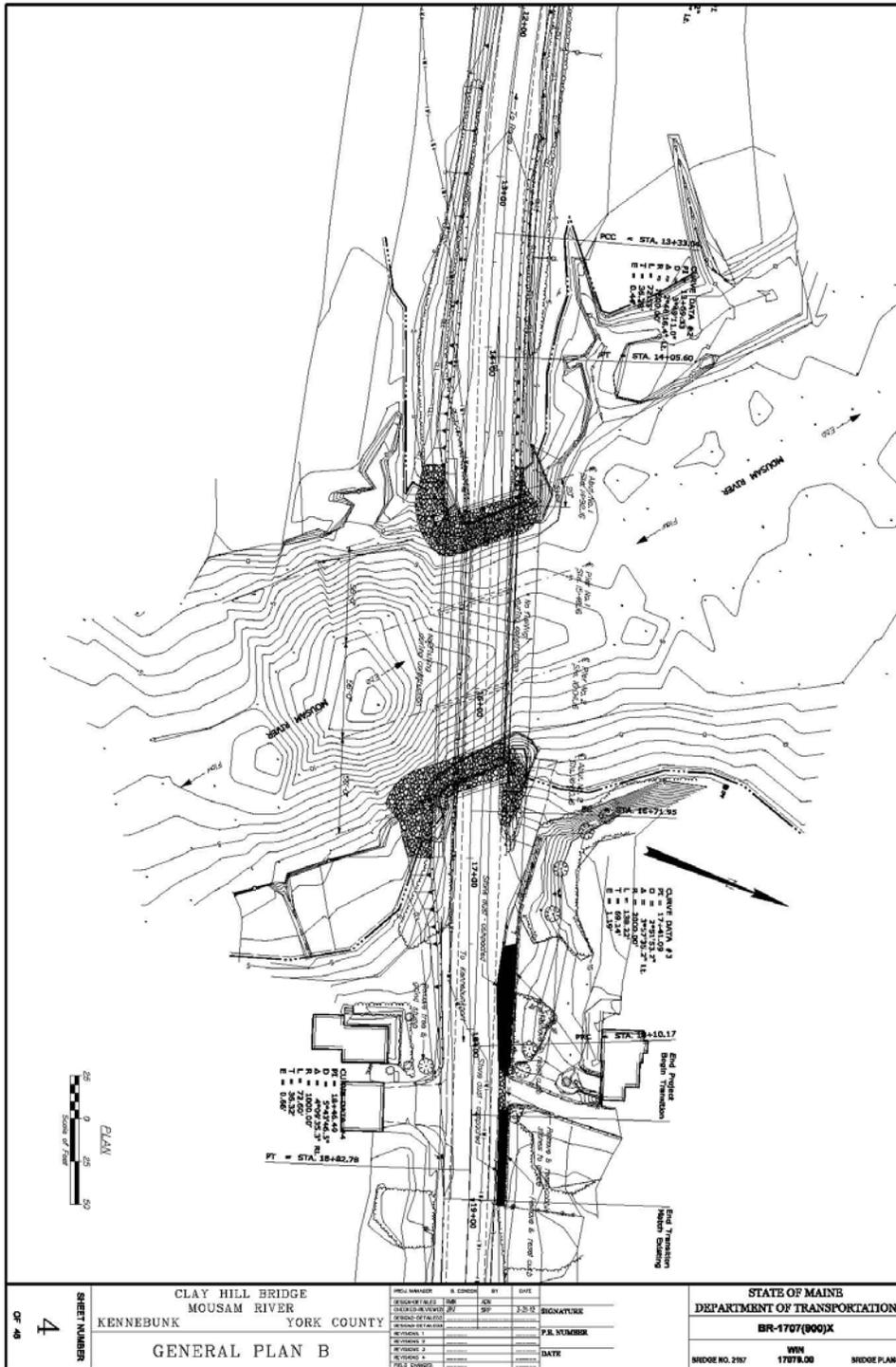


Figure 2
 General Plan View

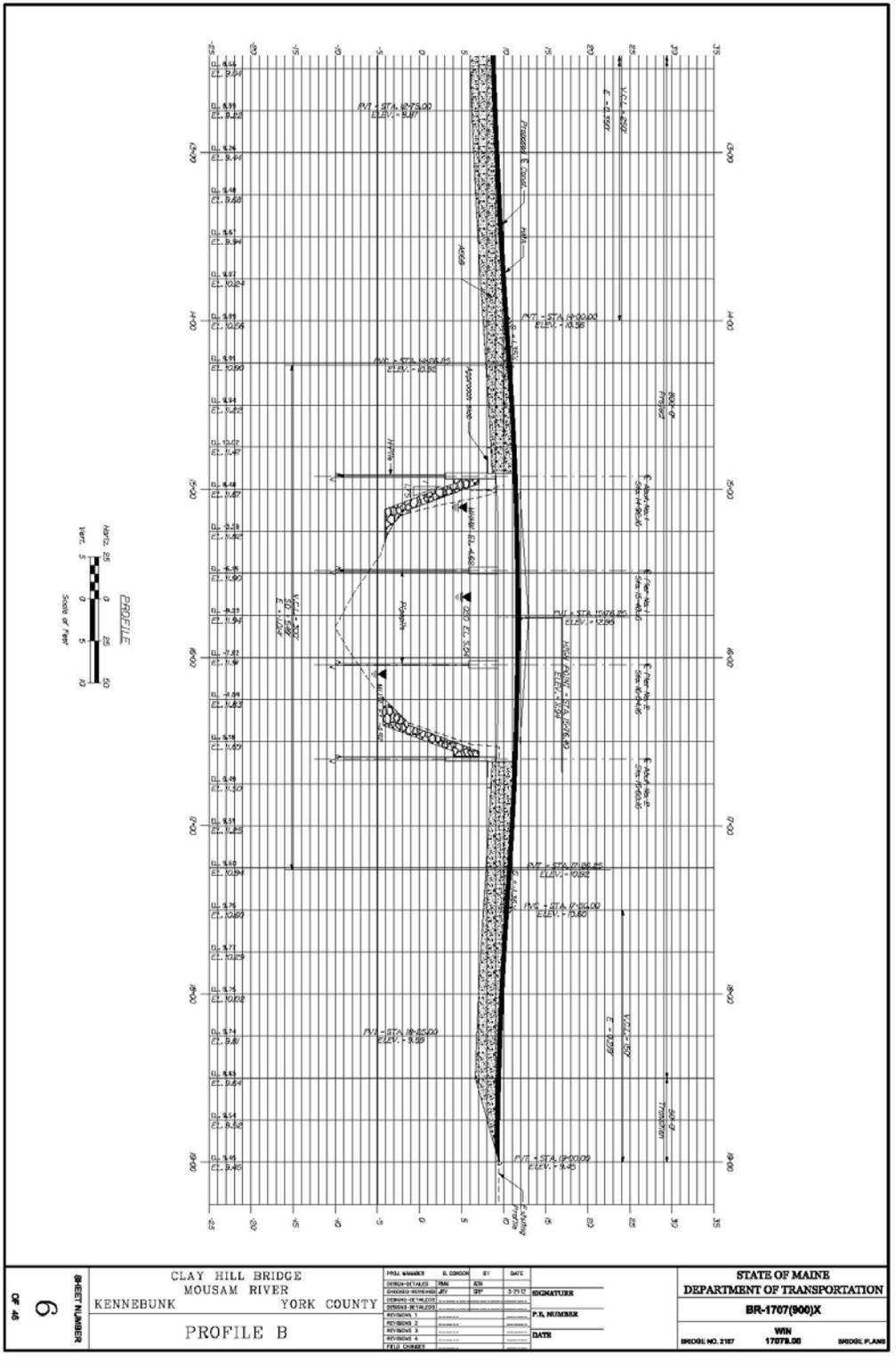
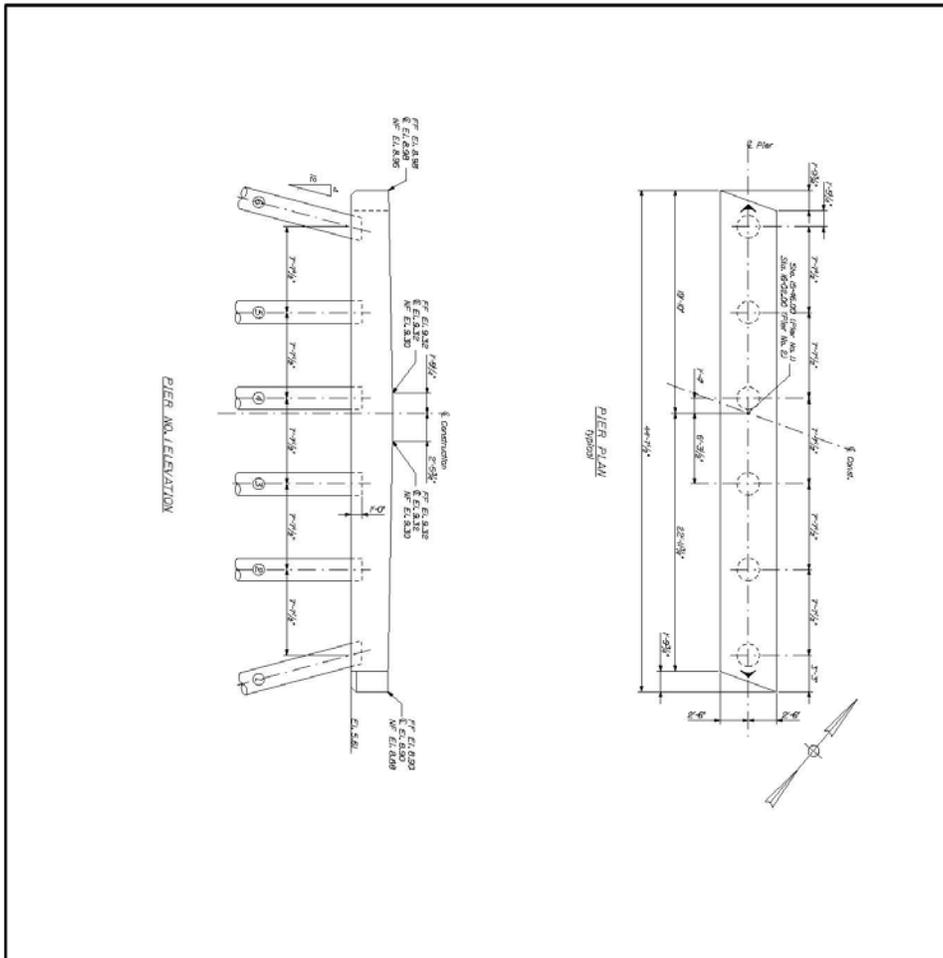


Figure 3
 Profile View 'B' Showing Pipe Pile Locations



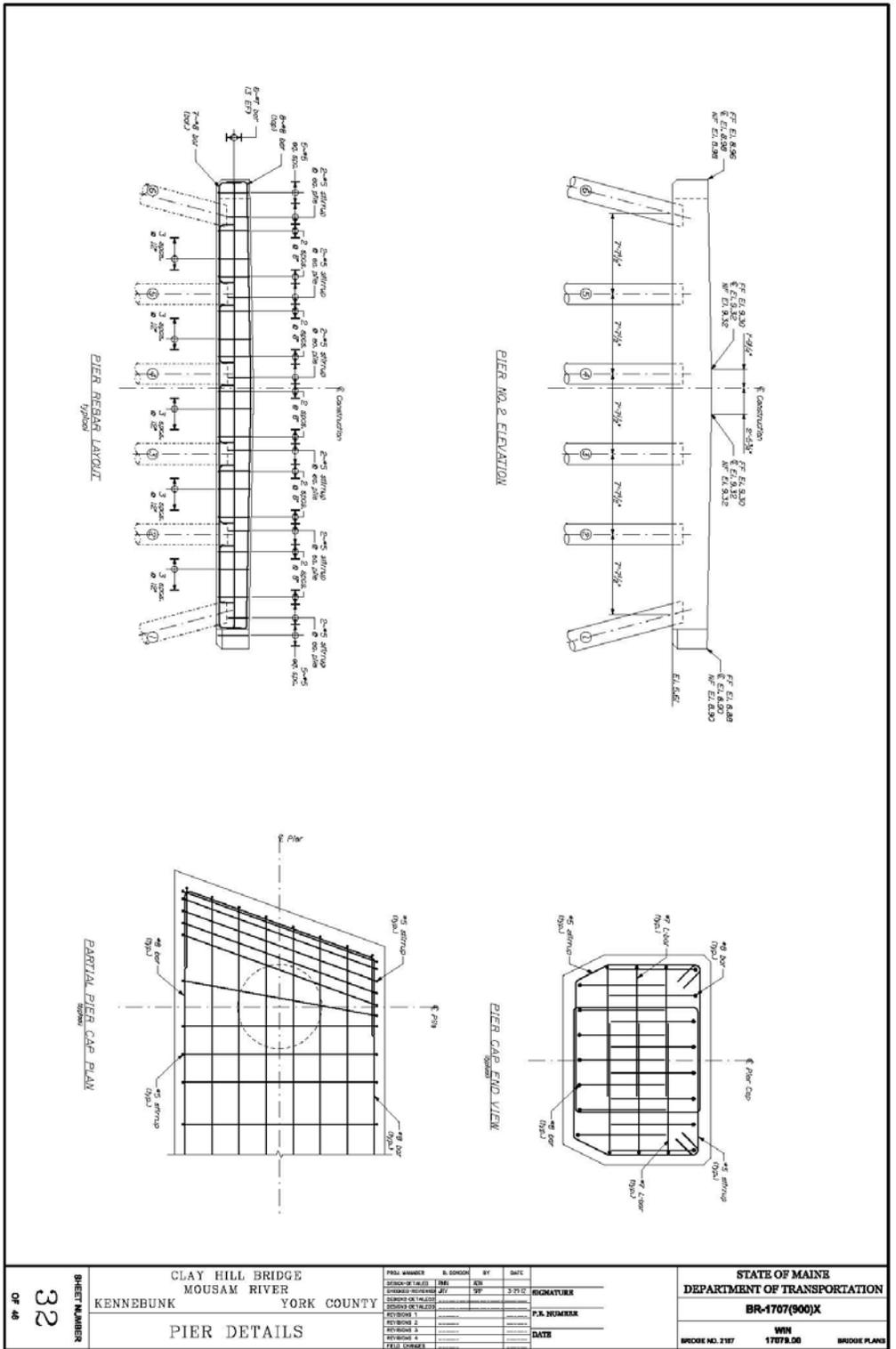
PIER NOTES
 1. Refer to the notes on the adjacent sheets for additional information.
 2. The maximum concrete depth shall be 5700 lbs.
 3. Refer to the notes on the adjacent sheets for additional information.

PILE NOTES
 1. The maximum concrete depth shall be 5700 lbs.
 2. Refer to the notes on the adjacent sheets for additional information.

PIER DESIGN CRITERIA
 1. The pier shall be designed for a design wind speed of 100 mph.
 2. The pier shall be designed for a design seismicity of 0.2g.
 3. The pier shall be designed for a design temperature of 100°F.
 4. The pier shall be designed for a design load of 100 kips.
 5. The pier shall be designed for a design moment of 1000 k-ft.
 6. The pier shall be designed for a design shear of 100 kips.
 7. The pier shall be designed for a design axial load of 1000 kips.
 8. The pier shall be designed for a design lateral load of 100 kips.
 9. The pier shall be designed for a design torsion of 100 k-ft.
 10. The pier shall be designed for a design vibration of 0.2g.

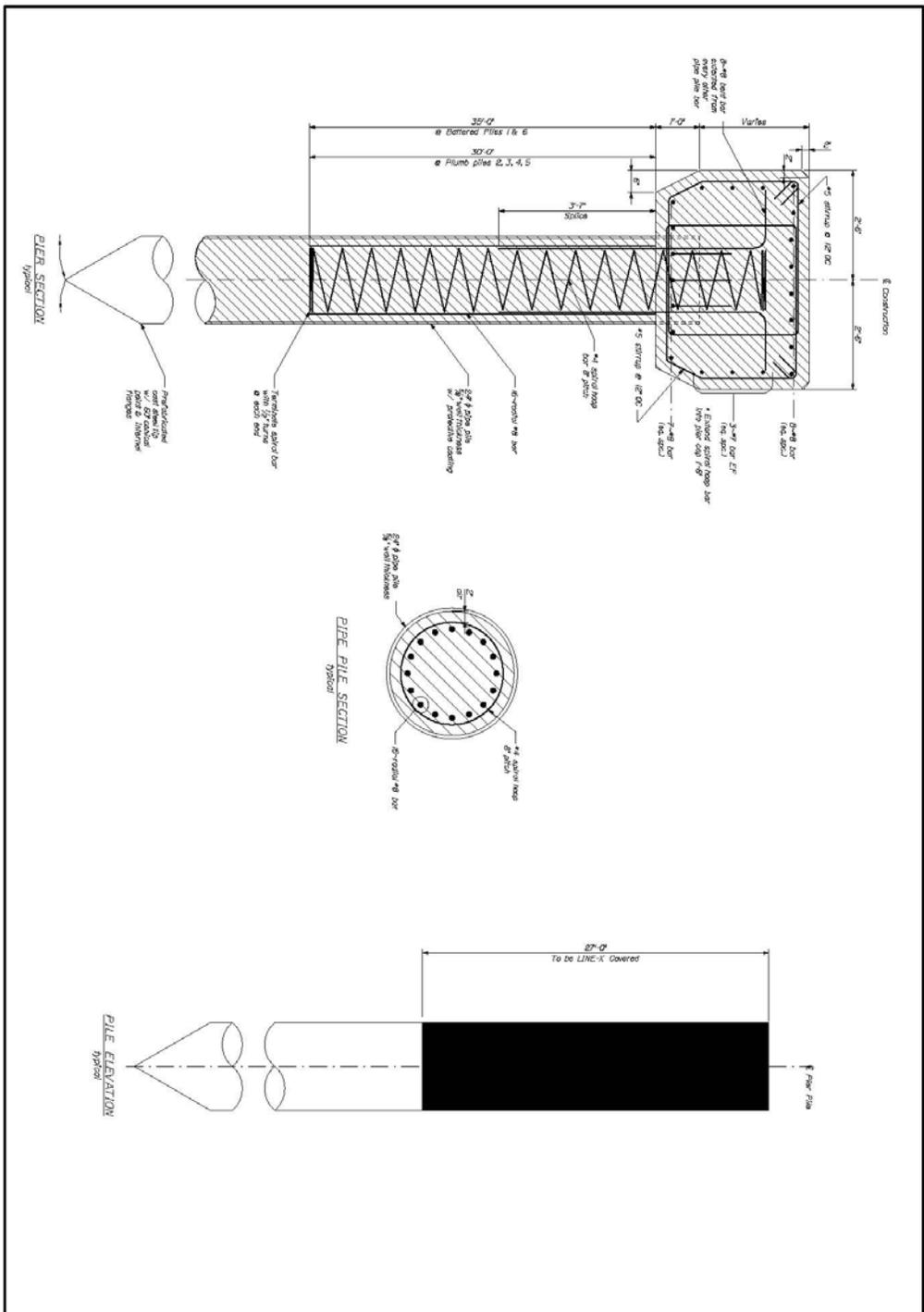
STATE OF MAINE DEPARTMENT OF TRANSPORTATION BR-1707(900)X WIN 1707B.DG BRIDGE NO. 1707	
SHEET NUMBER 31 OF 49	CLAY HILL BRIDGE MOUSAM RIVER KENNEBUNK YORK COUNTY PIER PLAN
P.O. NUMBER DATE	SIGNATURE DATE

Figure 4
 Pier Plan



SHEET NUMBER 32 OF 48	CLAY HILL BRIDGE MOUSAM RIVER KENNEBUNK YORK COUNTY	PROJ. NUMBER: B. 03000 SHEET NO.: 32 OF 48 DESIGNED BY: JAV CHECKED BY: JAV DATE: 3/27/12	SIGNATURE: _____ P.R. NUMBER: _____ DATE: _____
	PIER DETAILS	STATE OF MAINE DEPARTMENT OF TRANSPORTATION BR-1707(900)X WIN 1/17/08.DWG BRIDGE PLANS	

Figure 5
Pier Details



33 SHEET NUMBER OF 48	CLAY HILL BRIDGE MOUSAM RIVER KENNEBUNK YORK COUNTY	PIER NUMBER B. SPOON NO. 1	SHEET NO. 39	DATE 3/21/12	SIGNATURE _____
	PIER DETAILS	REVISION 1 REVISION 2 REVISION 3 REVISION 4 FIELD CHECKS	P.A. NUMBER _____	DATE _____	STATE OF MAINE DEPARTMENT OF TRANSPORTATION BR-1707(900)X WIN 1/17/10.DWG BRIDGE PLANS

Figure 6
 Pile Evaluation Showing Line-X® Coating Limits

Construction

The contract for the bridge replacement project was awarded to Technical Construction, Inc. of Turner, Maine on May 22, 2012.

H.B. Fleming of South Portland, Maine drove the steel pipe piles and H-piles on the project. At the suggestion of Larry Maillet (Line-X® of Augusta), Fleming fabricated a driving frame with intergral rollers (Photo 9) as an aide in reducing coating wear during the pile driving process. This appeared to be quite effective in reducing wear and tear on the coating.

The contractor performed wave equation analysis which includes the proposed driving system and stopping criteria. Stopping criteria include the blows per inch and the number of one inch driving intervals at which the pile installation may be terminated.

Dynamic load testing was performed to determine the ultimate capacity of the pile. This test is performed on the first production pile driven at each abutment.

Vibratory driving of piles began on Monday, November 19, 2012

Impact driving of piles began on Tuesday, November 20, 2012 with an APE D36-26 single-acting diesel hammer with a rated energy of 89,302 ft. lbs.

After driving was completed, the tops of the piles were cut to the required elevation in order to accommodate the pier cap. Cutting of the steel piles was accomplished by mechanical means with a rotary cutter (9 inch cutting wheel) straight through the coating and steel.

Comments were favorable regarding the Line-X® coating from Construction and MaineDOT personnel regarding the apparent toughness and aesthetics of the Line-X® coating throughout the project.

No areas of the Line-X® coating material received significant damage or required repair on any of the pipe pile surfaces.

Costs

The cost for Line-X® coating of twelve steel pipe piles was a lump sum total of \$46,824.00. This was a negotiated figure agreed upon between MaineDOT and Line-X® prior to project advertising. As outlined in the Special Provision (Appendix A), the cost included preparation of the steel piles, applying the primer and topcoat, adhesion testing and having representatives on-site to perform repairs if needed.

This figure works out to be \$3902.00 per pile, or \$23 per square foot. The total includes costs that likely would not be incurred in the future, such as having Line-X® personnel at the jobsite in case repairs are required. Additionally, in the future it may be possible to coat the piles in Maine according to Line-X® of Augusta personnel.

The cost may have been further reduced by electing to go with a thinner film thickness than the 125 mils that were specified. Due to our lack of experience with this material for this application, it was felt that the 125 mils would provide a margin of safety. Specifically, there was concern that the coating would suffer wear and abrasion during the transporting, handling, and driving process and this did not turn out to be the case. It may also be possible to go with a less expensive coating such as “Line-X® 100” for example. Line-X® representatives have cautioned against thinner coating thicknesses, pointing out that the strength of the material comes from its thickness and that the Line-X® 100 material might be more vulnerable to damage.

For a recent comparison with FBE costs, I found the cost of fusion bonded epoxy used on steel pipe piles in Boothbay Harbor (Knickerbocker Bridge Project) in 2009. That cost worked out to be about \$5 per square foot. There were fourteen piles of varying lengths. The entire length of each pile received the FBE coating. It must be noted that this is not a direct comparison between the two systems.

Pipe Pile Coating, Dagus Mines, PA

The pipe piles were delivered to Line-X®’s facility in Dagus Mines, PA after fabrication. The piles were prepared for coating by first soda blasting. This provided a near white surface profile .

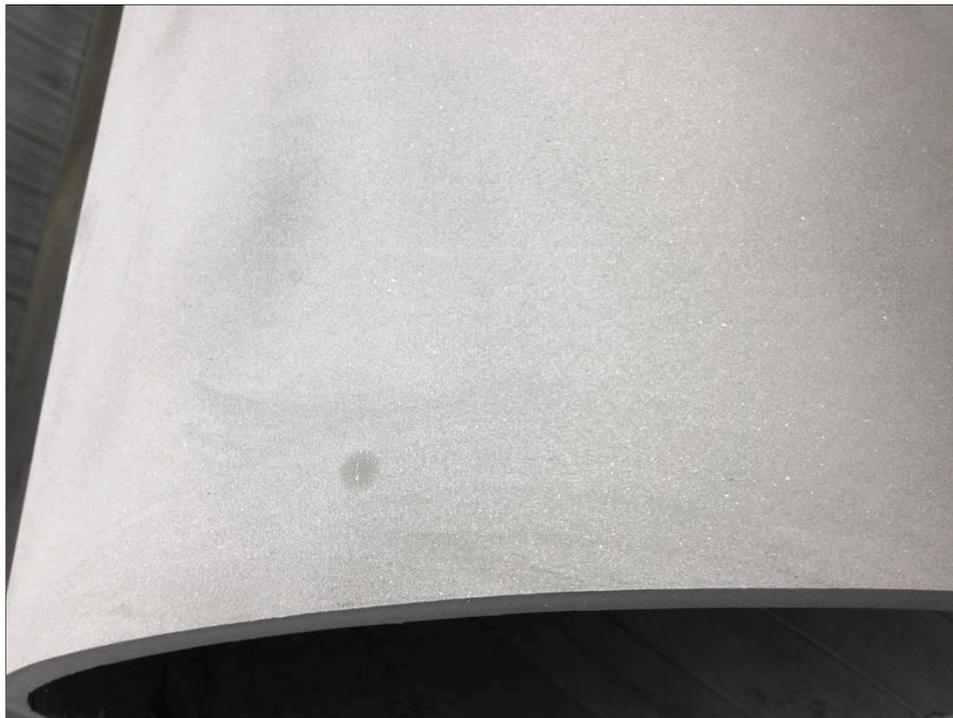


Photo 1

Steel pile surface profile immediately after soda blasting.

Although the Dagus Mines facility has an indoor blast booth, this work was performed outdoors. The piles were then brought inside an enclosed building in an effort to reduce contamination between blasting and priming phases.



Photo 2

Piles ready for inspection and priming. Note rolling cradle to facilitate a 360° application of the Line-X® product.



Photo 3

Line-X® personnel checking DFT after curing revealed a 0.5 mil average difference from the earlier WFT measurements. Pull-off tests were performed for each pile to monitor adhesion consistency



Photo 4
Pile receiving topcoat of Line-X®'s 100% polyurea 'XS-350'



Photo 5
Coated piles awaiting shipment to the jobsite.

Pile Driving, Kennebunk, ME



Photo 6

Preparing vibratory hammer for driving. Note the hole near the top of the pile. An acetylene torch was used causing the coating to char and burn. MaineDOT and Line-X® did not recommend this method of cutting due to testing that was conducted prior to the project.



Photo 7

APE D36-26 diesel hammer at work



Photo 8
Pile driven to the water line

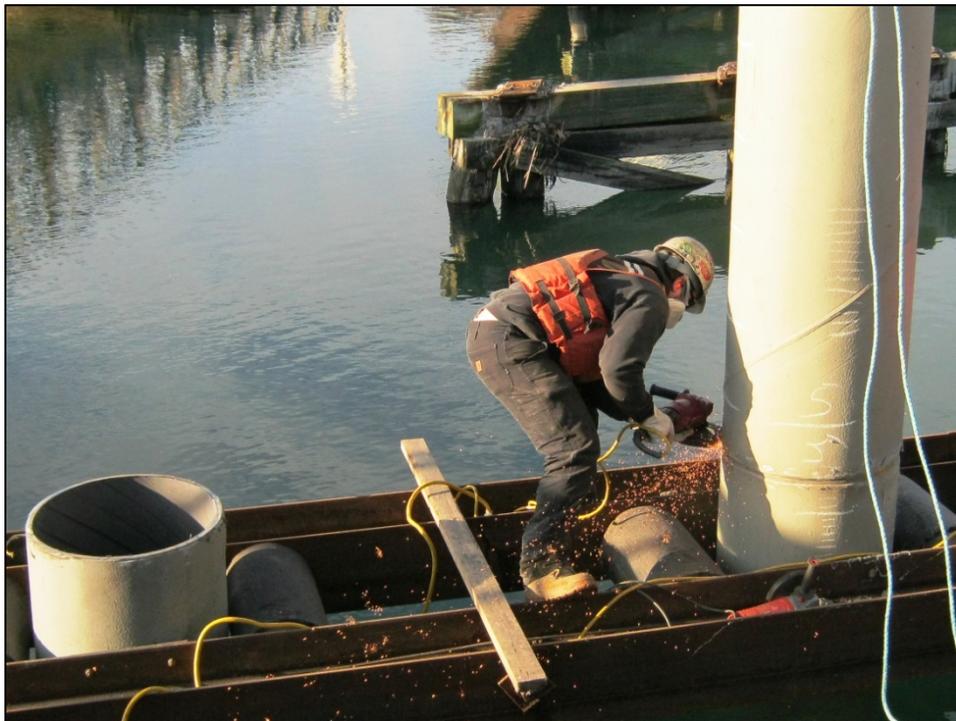


Photo 9
Cutting pile to final grade with a cut-off wheel



Photo 10

Preparing the two angled piles for driving by removing the coating where the hydraulic clamp was to grab the pile. A hand held jackhammer with a chisel bit was used to remove coating, which took considerable effort.



Photo 11

The topcoat debonded at the primer, which held fast to the steel beneath.



Photo 12
All pier piles driven and cut to final grade

Testing

According to the project specifications, adhesion tests of the Line-X® coating material were performed in accordance with ASTM D 4541 *Pull-Off Strength of Coatings Using Portable Adhesion Testers*. Tests were performed at the Line-X® facility in Dagus Mines, PA on each pile. The minimum adhesion value allowed by the project specifications was 1000 psi. The minimum adhesion value was exceeded in all cases by an average of 134% (Appendix A).

Pile #	Adhesion Value PSI	Type Break %		
		Adhesive	Cohesive	Glue Failure*
1	1386	0	20	80
2	1386	0	40	60
3	1182	0	40	60
4	1100	0	15	85
5	1304	0	10	90
6	1386	0	50	50
7	1467	0	10	90
8	1365	0	10	90
9	1018	0	10	90
10	1500+	0	30	70
11	1500+	0	20	80
12	1500+	0	20	80

Figure 7

Note: Tests 10, 11, and 12 reached the tester maximum and were removed manually.

*The test dolly pulled off the coating before the coating failed on the pipe.

According to Line-X®'s XS-350 Technical Data Sheet, the following lab testing was done per ASTM D543 for immersion of XS-350 in various fluids. Here are two fluids that we know will be encountered in the field. For a more complete list, see the Technical Datasheet (Appendix B).

Chemical Names	Volume Change (%)	Hardness Change (%)	Elongation ASTM D412 Change (%)	Tensile Strength ASTM D412 Change (%)	Recommended
Sea Water	3	-7	79	24	Yes
Water	2	-9	77	29	Yes

Conclusion

Observations and suggestions for future use of Line-X® coatings:

- Having a coating repair crew standing by is not necessary.
- The specification for the design of the driving frame provided excellent coating protection.
- There was no significant dry film thickness loss during the driving process.
- Coating at the spiral weld reinforcement displayed excellent adhesion.
- Removal of the coating using an electric chisel was extremely difficult and eventually resulted in an intra-coating failure of the primer, not the 350 coating.
- Attempted removal of coating on pile cutoffs after driving using extremely sharp chisels and a three pound hammer was futile.

Dan Glenn (MaineDOT) stated that requiring 125 mils might be excessive. Based on the performance of the coating that Dan observed, a thinner coating on piles in the future might result in an acceptable product at a reduced cost. Adequate surface preparation, e.g. blast cleaning and development of an angular anchor profile, and the application of the recommended primer are key elements in assuring proper adhesion to the steel substrate. Dan further suggested that it would be interesting to coat a pipe pile with Line-X® 100* or an equivalent to compare it to the performance of Line-X® 350.

*XS-100 is a hybrid polyurea & polyurethane coating manufactured by Line-X®.

None of the Line-X® coated piles on this project required welding in the field. Occasionally, this may be required. It will be interesting to see how the re-coating over the field-welded areas is accomplished on future projects.

There may also be other applications such as coating of structural steel within the substructure and coating of H-beam piles.

Transportation Research will monitor the condition of the Line-X® coating used on this project for durability and aesthetics for at least a five-year period.

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Photo Credits: Dan Glenn, MaineDOT
Cal Yeaton, MaineDOT
Chris Mellin, Line-X®
Mark Sides, Line-X®
Larry Maillet, Line-X® of Augusta

References

Line-X® Protective Coatings - <http://www.linex.com/>

ThomasNet.com - <http://www.thomasnet.com/articles/chemicals/epoxy-fusion-bonded>

Kennebunk
Clay Hill Bridge
WIN 017079.00
April 9, 2012

506.44 through 506.49 RESERVED

POLYUREA ELASTOMER COATING

506.50 Description This work shall consist of surface preparation, application, protection and field repair of a proprietary protective coating system applied to pipe piles. The work shall be done in accordance with the Manufacturer's Product Data Sheets, Material Safety Data Sheets (MSDS) and this Specification. In case of conflict, this Specification shall be followed.

The Contractor shall provide safe access to the operation for both Line-X coating repair personnel and the QAI. Failure to provide safe access will be deemed denial of access to the work and all work performed will be subject to rejection.

506.51 Materials The protective coating system shall be a two coat system manufactured and provided by:

Line-X Franchise Development Co.
1862 Sparkman Drive
Huntsville, AL 35816
Tel. 877-330-1331

The protective coating system shall consist of:

FCP primer as provided by Line-X
Line-X, XS-350, 100% polyurea elastomer coating

506.52 Submittals Submit the coating batch description, lot number, date of manufacture, shelf life and manufacturer's storage requirements to the QAI. Submit the Manufacturer's Product Data Sheet and MSDS for each coat of the coating system. Submittal shall include equipment requirements, surface preparation and cleanliness requirements, anchor profile, mixing, thinning, application, and cure time for the entire range of allowable environmental conditions and the DFT of each coat.

Submit a field process plan including method for cutting of coated pile, method for constraining coated pile in the template during driving, method of cushioning of the driving frame and protection of the pile during driving to prevent damage.

Submit a field repair plan for Line-X, XS-350, 100% solid polyurea elastomer coating that may potentially be damaged during the transportation or installation of the pipe pile. Submittal shall include equipment needed and an approximate time to effect repairs. The

plan shall include repair procedure for only Line-X, XS-350 damage and Line-X, XS-350 and FCP primer damage.

Submit all plans to the Department for review a minimum of two weeks prior to the beginning of the pile coating operations.

506.53 Notification The Contractor shall contact the Line-X representative listed below to coordinate the receiving, coating, shipping and field repair of the pipe piles.

Larry Maillet
LINE-X of Augusta
509 Maine Avenue
Farmingdale, ME 04344
(207)582-0282 work
(207)212-1995 cell
linexofaugusta@netscape.com

The Contractor shall notify the Fabrication Engineer at least fifteen business days prior to beginning the surface preparation/coating process in order to facilitate the presence of a QAI. Work performed without a QAI present will be subject to additional destructive and non-destructive testing and may make the coating subject to rejection. Rejection requires that the coating be removed and re-applied.

506.54 Inspection, Non-Conforming Work, Applicator Qualification and Documentation The Contractor shall meet the requirements of Sections 506.05 through 506.09. The Contractor shall assign unique alpha-numeric identification to each pipe pile. Each pipe pile shall be considered a separate unit for the purposes of inspection and documentation.

506.55 Surface Preparation Surface cleanliness shall meet the requirements of SSPC-SP 10, Near-White Blast Cleaning (SP 10) unless a higher standard of surface cleanliness is required by the Manufacturer's Product Data Sheet. Surfaces shall be uniform, free of sharp edges, weld spatter or other conditions injurious to coatings. Round all exposed nicks gouges and sharp changes in geometry to approximately a 3/32 inch radius prior to abrasive blast cleaning. A series of tangents that approximate a radius may be considered as a rounded edge if there are no sharp breaks. Provide radius gauges to inspect corner preparation. Sharp angular changes in the surface such as nicks, gouges and weld toes shall be blended to a smooth transition with the surrounding surfaces. SSPC-VIS. 1 shall be used to determine acceptable cleanliness. Provide a minimum blast media angular anchor profile of 3 mils.

The abrasive blast media shall meet the requirements of SSPC-AB 1, Mineral and Slag Abrasives, AB 2, Cleanliness of Recycled Ferrous Metallic Abrasives and/or AB 3, Ferrous Metallic Abrasive. The anchor profile shall be angular and meet the requirements of the coating manufacturer's published data sheet.

If compressed air is used for abrasive blast cleaning, perform a blotter test ASTM D 4285 at the beginning of each shift and at any time requested by the QAI. Notify the QAI prior to performing the test.

Measure and record the anchor profile in accordance with ASTM D 4417 Method C (replica tape). If the anchor profile fails to meet the minimum requirements, re-blast the substrate until the required anchor profile is achieved. If the anchor profile exceeds the maximum allowed, generate an NCR describing the condition of the substrate and a proposed solution and submit it to the Fabrication Engineer for review.

If it has been established to the satisfaction of the QAI that the abrasive blast equipment is capable of providing uniform, acceptable anchor profile, a diminished degree of testing may be allowed at the discretion of the Fabrication Engineer.

The allowable time between abrasive blast cleaning and primer application shall not exceed the manufacturer's published recommendations or one work shift, whichever is less. Any evidence of rust bloom, flash rust or other surface conditions that cause the substrate cleanliness to fall outside the specified cleanliness standard will be rejected. Inspect all substrate immediately prior to coating application. Re-blast steel substrate that does not meet the surface cleanliness requirements.

506.56 Application Limit of coating application shall be the top 27 feet of pipe piles. Record the batch and lot numbers of the coating, the type and amount of thinner used, the time and pot life of the coating. Measure the environmental conditions in the immediate vicinity of the piece(s) being coated.

Coating system shall be applied and cured in accordance with the Manufacturer's Product Data Sheet or equal. The Line-X, XS-350 shall be applied using heated (between 120° - 150° F) high pressure plural component spray equipment. Coating shall be uniform, smooth and free of holidays, sags, runs or drips.

506.57 Dry Film Thickness The DFT of the FCP primer shall comply with manufacture requirements; the DFT of the Line-X, XS-350, 100% solid polyurea elastomer coating, shall be at least 125 mils. Measure and record the DFT of each coat using a fixed-probe gauge in accordance with SSPC-PA 2. Record the following:

- A. Gauge type/manufacturer/model
- B. Serial Number

- C. Coat/shim used for calibration (e.g. Primer Coat/5 mil. shim)
- D. Measurements/spot average/location
- E. Cure time
- F. Non-conforming areas and determination for correction

506.58 Adhesion The primer/coating system shall have a minimum adhesion value of 1000 psi. Test the adhesion in accordance with ASTM D 4541-*Pull Off Strength of Coatings Using Portable Adhesion Testers*. The frequency of testing shall be one test per pile. The test location will be as directed by the QAI. The specified tensile force shall be applied to the coating and removed. If the test does not reveal a failure of the coating, the adhesion will be considered acceptable. If a reasonable consistency of acceptable adhesion is demonstrated, the frequency of testing may be reduced at the discretion of the Fabrication Engineer. If the coating fails the test, cease the coating operation until the problem is identified and corrected. Record the testing results in accordance with Section 506.05. Perform tests on each coated piece unless a lesser frequency of testing is directed by the Fabrication Engineer. If a pile is not tested, record "not tested" in the testing file.

To avoid damaging the pile coating, testing may be performed on witness panels that are coated at the same time that pipe piles are coated or on a coated pile surface that extends beyond the plan limits.

506.59 Handling, Shipping and Storage Handle coated members in a manner that avoids damage to the coating. Lift and move members using non-metallic slings, padded chains and beam clamps, softeners or by other non-injurious methods. Store and transport the pipe piles in a manner that prevents damage to the coating. The Contractor shall work with Line-X to determine and use the best possible handling, shipping and storage means that will avoid damage to the coating.

Load the pipe piles on trailers in a manner that prevents coating damage due to impact or abrasion during transit. Document damage to the coating that is discovered after the product is loaded for shipment to the job site. Minor damage as a result of handling shall be considered field repair unless, in the opinion of the Fabrication Engineer the damage is the result of negligence or poor handling methods. Damage that is deemed to be the result of negligence or poor handling methods shall be repaired as directed by the Fabrication Engineer.

506.60 Construction The Contractor shall arrange with the Line-X representative named in 506.53 to have a Line-X representative on site during pipe pile driving operations that is qualified to evaluate coating damage, including measuring and recording of DFT and that is qualified to effect repairs to damaged coating in a manner acceptable to the Department. The Line-X representative shall remain on the project for the duration of the pile driving operation unless otherwise directed by the Resident.

The Contractor shall handle the coated pipe piles in a manner that does not cause impact or abrasive damage by the pile driving leads, driving hammer or pile driving frame. The driving frame shall be cushioned or coated to prevent damage to the coating during pile driving. If the Line-X, XS-350, 100% solid polyurea elastomer coating is damaged during the driving operation, the Contractor shall cease pile driving and have the damage evaluated by a Line-X representative and repaired as per the submitted and approved field repair plan or as directed by the Resident. Do not continue driving the repaired pile until the coating has cured. Coating that has been damaged but retains 80 mils or more of undamaged Line-X, XS-350 coating need not be repaired if the Resident concurs. Coating that has been damaged by thermal cutting but will be embedded in the concrete pile cap need not be repaired.

Coating damaged during installation due to pile driving, cutting, welding or other operation shall be repaired as per the submitted and approved field repair plan or as directed by the Resident and the Line-X representative on site. Coated pipe pile shall be cut in accordance with submitted and approved field process plan using a plasma arc cutting process in combination with initial grinding off of the coating at the cutline to facilitate plasma arc cutting or other method approved by the Resident and the Line-X representative. In accordance with Line-X recommendations a heat sink comprised of wet fabric in contact the coating will be required adjacent to areas that will be thermal cut to minimize heat damage to the coating

If the Resident determines that the pile driving operation is progressing in a manner that makes severe damage to the coating unlikely, the Resident may curtail the full-time presence of the Line-X representatives. However, the Contractor shall assure that repair personnel are available to return to the site in a reasonable time period for any necessary repairs.

506.61 Field Repair Repair of damaged coating including, but not limited to scrapes, minor blemishes, scratches and abrasions resulting in less than 80 mils of Line-X, XS-350 coating remaining shall be the responsibility of the Contractor. Repairs shall be performed by Line-X in accordance with the approved field repair plan submittal using the same coating and methods specified in the Manufacturer's Product Data Sheet to the satisfaction of the Resident. Cure the repaired coating as directed by Line-X. Repaired pile shall not be driven until the coating has cured.

506.62 Method of Measurement Protective coating shall be measured by the lump sum, complete and accepted. The coating limits shall be as shown or described in the Contract Documents.

**Kennebunk
Clay Hill Bridge
WIN 017079.00
April 9, 2012**

506.63 Basis of Payment For bid purposes a contractor allowance of forty six thousand, eight hundred twenty four dollars and zero cents (\$46,824.00) has been included for Polyurea Elastomer Coating which will be paid for at the lump sum price for this item. Payment will be full compensation for all labor, materials and equipment required to complete the surface preparation and coating work, including, but not limited to, coating and cleaning materials, staging or accessing, testing, surface preparation, cleaning, application, and curing.

If at any time the Polyurea Elastomer Coating requires Field Repair the cost of repair shall be the responsibility of the Contractor.

Payment will be made under:

<u>Pay Items</u>	<u>Pay Unit</u>
506.9101 Galvanizing (and Top Coating)	Lump Sum
506.9102 Zinc Rich Coating System (Shop Applied)	Lump Sum
506.9103 Galvanizing	Lump Sum
506.9104 Thermal Spray Coating (Shop Applied)	Lump Sum
506.9105 Polyurea Elastomer Coating	Lump Sum
506.9106 Fusion Bonded Epoxy Coating	Lump Sum

Appendix B

TECHNICAL DATA SHEET – LINE-X® XS-350

PRODUCT MANUFACTURER:

LINE-X® Franchise Development Company
6 Hutton Centre Drive, Suite 500
Santa Ana, CA 92707

GENERAL PRODUCT DESCRIPTION:

LINE-X XS-350 is a two-component, 100% high performance aromatic polyurea spray elastomer system zero VOC (Volatile Organic Compounds), 100% solid. LINE-X XS-350 offers outstanding performance and superior elastomeric protective coatings for various substrates. LINE-X XS-350 is designed as a user-friendly product for moisture insensitive applications because of its pure polyurea chemistry, and offers exceptional adhesion properties for properly prepared substrates. The high performance formulation of LINE-X XS-350 produces an excellent skin formation for chemical resistance and moisture protection.

APPLICATION GUIDELINES:

Both the Iso “A” Side and Resin “B” Side should be preconditioned between 70-90°F before application. LINE-X XS-350 must be applied using high-pressure, plural component, heated, 1:1 by volume, spray equipment with 2000 PSI fluid pressure capability. LINE-X XS-350 material (both Iso “A” Side and Resin “B” Side) should be heated between 120-150°F. Spray equipment must generate adequate fluid pressure for proper mixing and best polymerization results.

APPLICATION EQUIPMENT:

LINE-X XS-350 is designed to be sprayed through high pressure impingement mixing equipment. Plural component spray equipment must have material heat-control capability, 1:1 by volume, and sprayable with round or flat tip. Refer to equipment manufacturer for equipment specifics and accessories.

EQUIPMENT SETTING PARAMETERS:

Iso “A” and Polyol “B” components must be pumped by low-pressure transfer pumps to a suitable high-pressure proportional pumping system.

Temperature Settings:	
Iso “A” Block Heater:	140-160°F
Resin “B” Block Heater:	140-160°F

Hoses (Iso and Polyol):	140-150°F
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Hydraulic Pressure Setting:	
Equipment Hydraulic Pressure:	2,000- 2,500 PSI

EQUIPMENT CLEAN-UP:

Spray equipment should be cleaned immediately after use following equipment manufacturer’s recommended procedures. Please refer to spray equipment operating and maintenance procedures for further details. LINE-X XS-350 should be cleaned with environmentally safe urethane grade cleaners. Cleaning materials must be free of reactive contaminants such as water and alcohol. All gun cleaners and spray equipment cleaning materials must be used and disposed of as permitted under local rules and regulations.

MATERIAL STORAGE:

LINE-X XS-350 has a shelf life of twelve (12) months from manufacture date in factory sealed containers. LINE-X XS-350 should be stored between 65-80°F. Do not expose unused materials to high humidity conditions. Always provide airtight reseal conditions to unused materials. For materials that are currently connecting to the pumps, always provide as much airtight and moisture free conditions to unused materials as possible to ensure proper chemical performance. Drums should be stored on pallets to avoid direct contact with the warehouse floor/ground.

SAFETY AND HANDLING:

Please refer to MSDS for safety and handling of this material. All personnel working with this material are expected to read and understand all safety recommendations per MSDS. All Personal Protection Equipment must be properly worn to comply with worker health and safety requirements.



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TECHNICAL DATA SHEET – LINE-X® XS-350

CHEMICAL TECHNICAL DATA:

Mix Ratio by Volume:	1A:1B
Gel Time:	6-9 Sec
Tack Free Time:	9-12 Sec
Viscosity (cPs) @ 77°F	
“A” Iso Side:	1000±100
“B” Resin Side:	370±50
Material Density (lbs/gal) @ 77°F	
“A” Iso Side:	9.5 lbs/gal
“B” Resin Side:	8.4 lbs/gal

BASIC PHYSICAL PROPERTIES:

All tests are performed by OCM Test Laboratories.

- ISO 17025 Certified
- American Association for Laboratory Accreditation (ARLA)

<u>Test Name</u>	<u>Test Methods</u>	<u>Value</u>
Hardness Shore D	ASTM D2240	60±1
Coefficient of Friction	ASTM D1894	
Static		0.305
Kinetic		0.127
Dielectric Const.	ASTM D150	3.6
Dissipation Factor	ASTM D150	0.031
Volume Resistance	ASTM D257	2.3x10 ¹⁴ ohm cm
Elongation	ASTM D412	82%
Flexural Strength	ASTM D790	2,630 PSI
Flexural Modulus	ASTM D790	0.056 MSI
Fungus Test	MIL-STD 810F	Pass
Pull-off Test-Adhesion	ASTM C297	
To Metal - No Primer		1,800 PSI
To Metal - XPM Primer		1,910 PSI
To Metal - LXSP515 Primer		1,870 PSI
Taber Abrasion	ASTM D4060	0.06980
(gm Loss/1000 cycles)		
Tear Strength	ASTM D624	497 lbs/in.
Tensile Strength	ASTM D412	2,010 PSI
Water Vapor Trans.	ASTM E96	0.499 Grains/Ft 2/Hr

ADDITIONAL PRODUCT CERTIFICATIONS:

- USFDA Coatings for Incidental-Food-Contact Applications Certified by Keller and Heckman LLP
- MIL-STD-810F



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TECHNICAL DATA SHEET – LINE-X® XS-350

Chemical Resistances per ASTM D543 for immersion in fluids methods:

Line-X XS-350 materials are immersed in the chemicals below for a period of 7 days; physical properties of pre and post-immersion were measured to quantify the changes in product physical properties.

Chemical Names	Volume Change (%)	Hardness Change (%)	Elongation ASTM D412 Change (%)	Tensile Strength ASTM D412 Change (%)	Recommendations
Acetic Acid 10%	6%	-13%	56%	-13%	Yes
Ammonium Chloride 30%	2%	-1%	76%	40%	Yes
Ammonium Hydroxide	2%	-1%	59%	22%	Yes
Automotive Gasoline	11%	-13%	-14%	-39%	Yes
Automotive Oil	13%	-14%	74%	45%	Yes
Aviation J.P. Fuel	8%	-8%	39%	-5%	Yes
Baking Soda 25%	3%	-4%	68%	30%	Yes
Benzene	13%	-16%	-37%	-72%	Yes
Bleach (Chloride)	2%	-7%	50%	12%	Yes
Boric Acid 3%	6%	-12%	65%	22%	Yes
Brake Fluid (DOT 3)	30%	-39%	7%	-48%	Yes-Secondary Containment
Calcium Chloride 50%	2%	-8%	71%	50%	Yes
Calcium Hypochloride 5%	4%	-5%	48%	11%	Yes
Citric Acid 10%	2%	-4%	71%	30%	Yes
Club Soda	3%	-5%	49%	13%	Yes
Cream Soda	2%	-6%	66%	22%	Yes
Crude Oil (Heating)	7%	-4%	35%	11%	Yes
Diesel Fuel	5%	-6%	48%	33%	Yes
Ethylene Glycol	3%	-7%	55%	19%	Yes
Formic Acid 10%	12%	-23%	60%	-29%	Yes-Secondary Containment
Formic Acid 5%	14%	-26%	61%	-31%	Yes-Secondary Containment
Hydraulic Fluid (Oil)	2%	-2%	45%	47%	Yes
Hydrogen Peroxide 30%	4%	-6%	55%	13%	Yes
Hydrogen Peroxide 10%	4%	-7%	80%	22%	Yes
Isopropyl Alcohol	32%	-34%	40%	-50%	Yes
Kerosene	8%	-6%	53%	9%	Yes
Lactic Acid 20%	4%	-7%	79%	18%	Yes
Lactic Acid 45%	7%	-13%	55%	5%	Yes
Methylene Chloride	12%	-22%	-51%	-84%	Yes
Mineral Spirits	4%	-1%	37%	13%	Yes



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Chemical Names	Volume Change (%)	Hardness Change (%)	Elongation ASTM D412 Change (%)	Tensile Strength ASTM D412 Change (%)	Recommendations
Phosphoric Acid 50%	4%	-5%	46%	27%	Yes
Potassium Hydroxide 50%	2%	-3%	65%	47%	Yes
Saline Solution 30%	3%	-8%	NA	NA	Yes
Sea Water	3%	-7%	79%	24%	Yes
Sodium Carbonate 10%	4%	-8%	57%	23%	Yes
Sodium Chloride 30%	2%	-4%	63%	31%	Yes
Sodium Hydroxide 50%	0%	4%	-9%	49%	Yes
Sodium Hydroxide 10%	2%	-8%	74%	26%	Yes
Sodium Sulfate 30%	5%	-7%	54%	6%	Yes
Sodium Sulfate 20%	2%	-1%	74%	30%	Yes
Sugar Solution 30%	2%	-6%	62%	23%	Yes
Sulfuric Acid 25%	2%	-2%	67%	39%	Yes
Sulfuric Acid 10%	2%	-8%	54%	28%	Yes
Tannic Acid 40%	4%	-7%	47%	30%	Yes
Toluene	17%	-18%	-29%	-63%	Yes
1,1,1 - Trichloroethylene	8%	-13%	-53%	-79%	Yes
Xylene	17%	-24%	-3%	-59%	Yes
Water (H2O)	2%	-9%	77%	29%	Yes

LIMITATIONS:

The chemical resistance chart should be consulted prior to application; this is an exhaustive chemical compatibility list quantifying pre and post physical properties for chemicals exposure per ASTM D543. Application specific processing parameters such as temperature, and operating pressure of coated objects must be considered before installing Line-X XS-350 coatings system.

PRODUCT USER RESPONSIBILITIES:

Users of Line-X XS-BK 350 product are responsible for reading the general guidelines, product data sheets, specifications and material safety data sheets (MSDS) before using this material. Printed technical data and instructions are subject to change without notices. Contact your local LINE-X representative or visit our website www.LineX.com for current technical data instructions.

PRODUCT DISCLAIMER:

All guidelines, recommendations, statements, and technical data contained herein are based on information and tests we believe to be reliable and correct, but accuracy and

completeness of said tests are not guaranteed and are not to be construed as a warranty, either expressed or implied. It is the users responsibility to satisfy himself, by his own information and test, to determine suitability of the product for his own intended use, application and job situation and user assumes all risk and liability resulting from his use of the product. We do not suggest or guarantee that any hazards listed herein are the only ones which may exist. Neither seller nor manufacturer shall be liable to the buyer or any third person for any injury, loss or damage directly or indirectly resulting from use of, or inability to use, the product. Recommendations or statements, whether in writing or oral, other than those contained herein shall not be binding upon the manufacturer, unless in writing and signed by a corporate officer of the manufacturer. Technical and application information is provided for the purpose of establishing a general profile of the material and proper application procedures. Test performance results were obtained in a controlled environment and LINE-X FDC makes no claim that these



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