CORRPRO COMPANIES INC
For Every Corner of Your World

Field Performance Evaluation of Polymer Coated CSP Structures in WISCONSIN

Prepared for:

NATIONAL CORRUGATED STEEL PIPE ASSOCIATION

March 2002

OBJECTIVES

The objectives of this study were to evaluate the field performance of polymer coated CSP at sites in Wisconsin. These installations included test sites previously inspected and documented by the Wisconsin Department of Transportation.[1] Of particular significance is the corrosive environment and age of the pipes, ranging from 17 to 27 years old.

CONCLUSIONS

- Of the alternative pipe materials observed at the joint Wisconsin/FHWA test installation, the polymer coated corrugated steel pipe performed as well as or better than the other materials (epoxy coated, aluminum coated type 2, and aluminum pipe). Only the epoxy coated pipe appears to be showing signs of corrosion at one end.
- The polymer coated CSP has performed very well at all 5 of the sites inspected, providing excellent corrosion protection in these aggressive environments for up to 27 years. The coating was intact, well adhered, pliable and appeared like new. There was minor damage to some of the polymer that was most likely the result of fabricating and handling. Where the galvanized substrate was exposed, there was no steel corrosion. At the cut ends, there was typically some corrosion and nominally ¼ inch of coating undercutting. These imperfec-

[1] *Corrosion Evaluation of Experimental Metal Culvert Pipe in Wisconsin—Progress Report IV,* Robert Patenaude, Wisconsin DOT, 1988

tions do not show any sign of impacting the expected service life.

- One installation had coating delamination on approximately 2 square feet of the surface area limited to the inside crown of the exposed end. There was no steel corrosion underneath the delaminated film and the zinc coating was intact. The polymer film was tightly adhered at the edges of the delaminated area.
- The overall condition of the pipes was typical of several hundred other pipes the author has inspected, demonstrating consistent performance, regardless of age.

BACKGROUND

The Wisconsin DOT initiated an investigation in 1980 to "observe the corrosion resistance of four types of culvert pipes the were not in widespread use in Wisconsin [in 1981]. Three sites on STH 80 in Juneau and Wood counties were selected on the basis of strong corrosiveness to zinc galvanized steel pipe." In describing the corrosive conditions at these sites the report concluded, "Corrosion at these sites appears to result from multiple causes. Historically, corrosion of steel in the natural environment has been attributed to low pH and low electrical resistivity of soil and water. In addition, anaerobic sulfate reducing bacteria have been recognized to cause corrosion of steel in moist organic-rich soil. It appears that the type of pipe least susceptible to corrosion in this type of environment is a pipe with an organic barrier coating, as polymer coated steel."

This study concluded that, "in comparison of performance of the four types of pipe at these three sites, the polymeric coated galvanized steel pipes evidenced the least distress. None of these [polymer coated] pipes were perforated and removal of the coating was localized to the vicinity of exposed rivet heads and section ends."

FIELD INVESTIGATION

On August 8 and 9, 2001 several polymer coated corrugated steel pipe installations were inspected in the state of Wisconsin by Corrpro Companies, Inc. Inspection included a thorough visual inspection of the coating and site, collection of soil and water samples for analysis, measurement of corrosion potentials, and photo documentation.

Wood County – Comparative pipe material study

This site consists of four pipes each fabricated from a different material—polymer coated, aluminum, aluminum coated type 2 and epoxy coated. Each pipe was 30 inches in diameter under State Highway 80, a two-lane road. The pipes carried runoff between woodland areas on either side of the road. The pipes were installed in 1981 as part of a joint Wisconsin DOT/FHWA research project.[1] At the time of the inspection, the installations were approximately 20 years old. Following is a description of each pipe condition:

Aluminum. One pipe was constructed of riveted aluminum. The pipe had several inches of standing water and approximately one inch of silt at the time of the inspection. Staining and very light pitting (not practicably measurable in the field) was present on pipe interior, especially in the invert.

Polymer Coated. One of the test pipes was polymer coated and riveted construction. The pipe had several inches of standing water and approximately one inch of silt at the time of the inspection. The polymer coating was well adhered and pliable. The coating thickness was 12 mils (polymer plus galvanized) both internal and external. Approximately ¼ inch of polymer could be lifted at some locations along the edge of pipe. Near the rivets, no polymer delamination was evident.

Epoxy Coated. One pipe at this site was spiral weld construction with an epoxy coating applied. The pipe had a few inches of heavily silted standing water at the time of the inspection. The coating thickness was measured between 22 to 26 mils. From the east end the coating was observed to be in good condition, including over the welds. The epoxy could only be chipped off of ¼ inch at the cut edge. The west end of the pipe showed coating damage, with the bottom 270 degrees of coating missing. Where the coating is missing, there is active corrosion but no perforation.

Aluminum Coated Type 2. One pipe at this location was helically fabricated from aluminum coated material with a galvanized end section. There was several inches of water saturated mud in the invert, possibly the cause of the higher observed water pH. The lockseam had some minor corrosion, otherwise the pipe appeared to be in good condition.

[1] *Corrosion Evaluation of Experimental Metal Culvert Pipe in Wisconsin—Progress Report IV,* Robert Patenaude, Wisconsin DOT, 1988

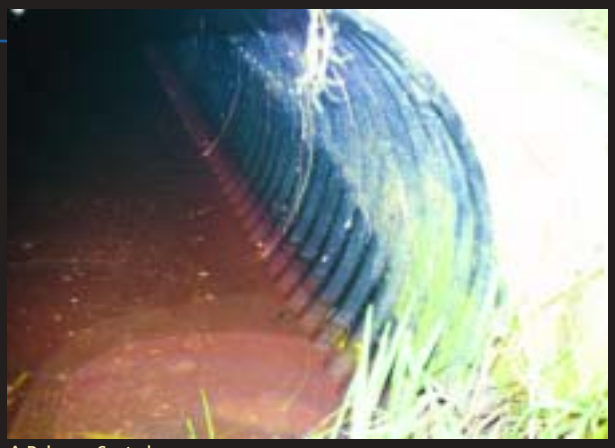
COLLECTED DATA

Wood County

Ecorr, mV	
1 Aluminum	-689
2 Polymer	-621
3 Epoxy	-544
4 Aluminum Coated Type 2	-577

Water Data	
Hardness, mg/L	n/m
pH	7.41
Resistivity, ohm-cm	1,612

Soil Data	
% Moisture	23.83%
Chloride, ppm	4
Sulfide, ppm	0
pH	7
Resistivity, ohm-cm	8,929



^ Polymer Coated

^ Epoxy Coated

^ Aluminum

^ Aluminum Coated Type 2

Adams County

At this location there was one, 30-inch diameter polymer coated pipe. The pipe was installed in 1974 and was 27 years old at the time of our inspection. The pipe carried agricultural runoff from a farm on the south end to a small, wooded pond on the north end of the pipe. Thickness measurements revealed that the polymer coating was 10 mils inside and 3 mils outside. On the interior of the southern exposed end, a triangle of polymer coating at the crown tapering back to the exterior cut edge of the pipe was delaminated (approximately 2 square feet). This area was slightly smaller than the exposed end. The polymer was tightly adhered at the edges of the delaminated area. There was no corrosion under the film. The polymer on the remainder of the pipe was well adhered.

COLLECTED DATA

Adams County

Ecorr, mV	-705
Water Data	
Hardness, mg/L	120
pH	6.62
Resistivity, ohm-cm	2,273
Soil Data	
% Moisture	9.73%
Chloride, ppm	20
Sulfide, ppm	0
pH	6.9
Resistivity, ohm-cm	3,774

^ Farm Drainage

^ Entrance

^ Outlet

Kewaunee County

Town Hall Road. This 30-inch diameter polymer coated pipe was installed in 1974. It was approximately 27 years old at the time of the inspection. It is riveted construction installed without end sections. Thickness measurements revealed that the polymer coating was 10 mils inside and 3 mils outside. Approximately 4 feet of pipe was exposed on either end and subjected to mechanical damage. The polymer coating was tightly adherent, even at the locations of mechanical damage. Negligible lifting of the polymer was possible when picked with a knife.

COLLECTED DATA

Kewaunee County: Town Hall Road

Ecorr, mV	-645
Water Data	
Hardness, mg/L	70
pH	6.75
Resistivity, ohm-cm	2,941
Soil Data	
% Moisture	37.9%
Chloride, ppm	21
Sulfide, ppm	0
pH	7
Resistivity, ohm-cm	1,704

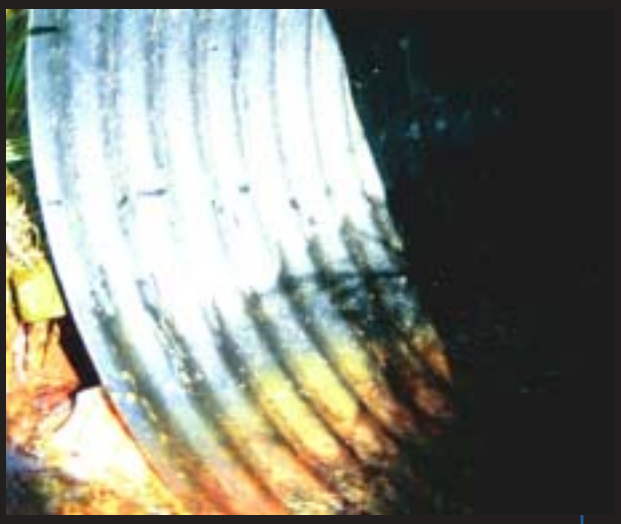
Kewaunee County

Cherneyville Road. This 36-inch diameter pipe is under a two-lane road adjacent to a cheese factory and was installed in 1977. Polymer thickness was confirmed to be nominally 10 mils inside and out. The invert was in good condition with a white, lime like material covering the invert and up the sides on the outlet end. At the inlet end, approximately ¾ inch of polymer could be lifted from the cut edge. The polymer was tightly adherent throughout the remainder of the pipe, including the outlet cut edge.

COLLECTED DATA

Kewaunee County: Cherneyville Road

Ecorr, mV	-557
Water Data	
Hardness, mg/L	265
pH	7.35
Resistivity, ohm-cm	1,667
Soil Data	
% Moisture	6.17%
Chloride, ppm	10
Sulfide, ppm	0
pH	8.1
Resistivity, ohm-cm	5,155



Forest County

This site has two, 72-inch diameter polymer coated pipes adjacent to each other. The pipes appear to have been installed in 1984, making them 17 years old at the time of the inspection. The pipes serve as equalizers between two swampy areas underneath an abandon railroad. There were no joints in either pipe. The polymer was well bonded and in good shape over the entire length of the pipe. There was minimal polymer peeling at the cut edge—maximum of ½ inch underwater, ⅛ inch in "dry" areas.

COLLECTED DATA

Forest County

Ecorr, mV	-596
Water Data	
Hardness, mg/L	75
pH	7.5
Resistivity, ohm-cm	4,000
Soil Data	
% Moisture	0.94%
Chloride, ppm	3
Sulfide, ppm	0
pH	8.1
Resistivity, ohm-cm	23,256

American Iron and Steel Institute
1101 17th Street, NW, Suite 1300
Washington, DC 20036-4700
www.steel.org/infrastructure